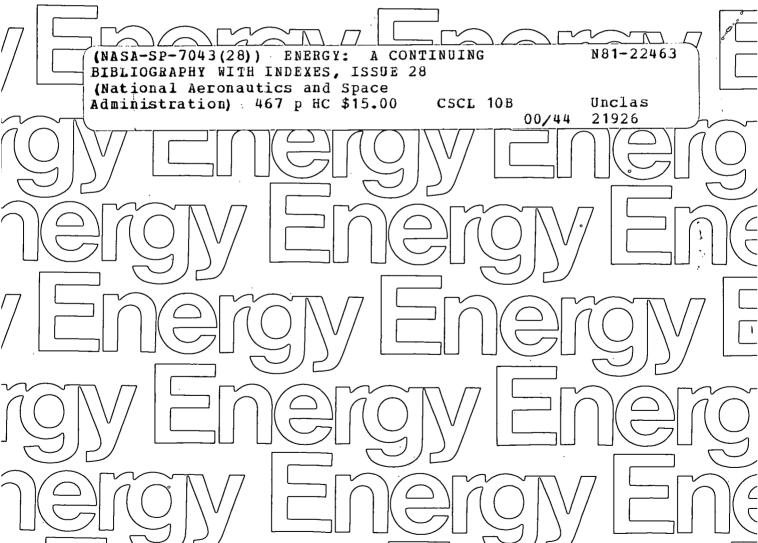


National Aeronautics and Space Administration





### **ACCESSION NUMBER RANGES**

Accession numbers cited in this Supplement fall within the following ranges:

IAA (A-10000 Series) A80-43839 - A80-54081 STAR (N-10000 Series) N80-28295 - N80-34339

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NASA SP-7043(24)	January 1980	October 1, 1979 – December 31, 1979
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## **ENERGY**

### - A Continuing Bibliography

With Indexes

Issue 28

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced from October 1 through December 31, 1980 in

- Scientific and Technical Aerospace Reports (STAR)
- International Aerospace Abstracts (IAA).

This supplement is available as NTISUB/026/093 from the National Technical Information Service (NTIS), Springfield, Virginia 22161 at the price of \$15.00 domestic; \$30.00 foreign.

### INTRODUCTION

This issue of Energy: A Continuing Bibliography with Indexes (NASA SP-7043(28)) lists 1610 reports, journal articles, and other documents announced between October 1, 1980 and December 31, 1980 in Scientific and Technical Aerospace Reports (STAR) or in International Aerospace Abstracts (IAA). The first issue of this continuing bibliography was published in May 1974 and succeeding issues are published quarterly.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, IAA Entries and STAR Entries in that order. The citation, and abstracts when available, are reproduced exactly as they appeared originally in IAA or STAR including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

Five indexes -- subject, personal author, corporate source, contract number, and report number -- are included.

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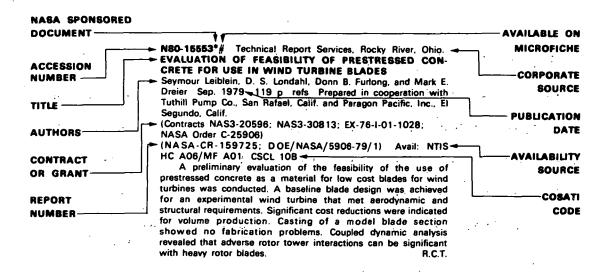
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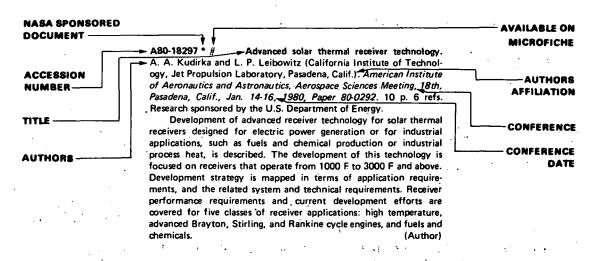
## **Subject Categories**

Abstracts in this Bibliography are grouped under the following categories:	page:
O1 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS Includes energy requirements, energy conservation, and environmental impacts of energy systems.	569
O2 SOLAR ENERGY Includes solar collectors, solar cells, solar heating and cooling systems, and solar generators.	595
O3 HYDROGEN Includes hydrogen production, storage, and distribution.	661
04 FUELS AND OTHER SOURCES OF ENERGY Includes fossil fuels, nuclear fuels, geothermal and ocean thermal energy, tidal energy, and wind energy.	669
05 ENERGY CONVERSION Includes photovoltaic, thermoelectric, geothermal, ocean thermal, and wind energy conversion. Also includes nuclear reactors and magnetohydrodynamic generators.	717
06 ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION Includes transport of fuels by pipelines, tubes, etc., microwave power transmission, and superconducting power transmission.	757
07 ENERGY STORAGE Includes flywheels, heat storage, underground air storage, compressed air, storage batteries, and electric hybrid vehicles.	761
08 GENERAL	781
SUBJECT INDEX	A-1
PERSONAL AUTHOR INDEX	B-1
CORPORATE SOURCE INDEX	C-1
CONTRACT NUMBER INDEX	D-1
REPORT/ACCESSION NUMBER INDEX	E-1

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### TYPICAL CITATION AND ABSTRACT FROM IAA



## A Listing of Energy Bibliographies Contained In This Publication:

1.	Heat pipes. Citations from the NTIS data base	p0781 N80-28680
2.	Heat pipes. Citations from the NTIS data base	p0781 N80-28681
3.	Heat pipes. Citations from the Engineering Index data base	p0781 N80-28682
4.	Heat pipes. Citations from the engineering index data base	p0781 N80-28683
5.	Hydrogen production. Citations from the NTIS data base	p0665 N80-29519
6	Hydrogen storage: Hydrogen as a hydride. Citations from the NTIS da	ta basa
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12.	data base	p0706 N80-31660
12. 13.	data base  Solar thermal heating and cooling. A bibliography with abstracts	p0706 N80-31660 p0649 N80-31963 p0751 N80-31965
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20. Lithium batteries. Citations from the Engineering Index data base	p0779 N80-32968
1. Hydrogen use as a fuel. Citations from the NTIS data base	p0667 N80-33607
2. State-of-the-art reviews and bibliographies on energy. Citations from the	NTIS data base p0782 N80-33917
3. State-of-the-art reviews and bibliographies on energy. Citations from the	NTIS data base p0782 N80-33918
4. Lead batteries. Citations from the NTIS data base	p0780 N80-33923
5. Lead batteries. Citations from the Engineering Index data base	p0780 N80-33924
6. Technology Assessment. Citations from the NTIS data base	p0783 N80-34299

## **ENERGY**

### A Continuing Bibliography (Issue 28)

**JANUARY 1981** 

#### 01

#### ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

Includes energy requirements, energy conservation, and environmental impacts of energy systems.

A80-43843 Environmental protection - Cooperation versus enactments (Umweltschutz - Kooperation statt Erlasse). K. Honsel (Wirtschaftsvereinigung Metalle, Düsseldorf, West Germany). (Wirtschaftsvereinigung Metall, Mitgliederversammlung, Bonn, West Germany, June 3, 1980.) Metall, vol. 34, July 1980, p. 659-662. In German.

The status of the nonferrous metal industry is surveyed. Attention is given to the general economic development, metal trade outlook, metal ore mining, smelting plants and remelting works. Further, semifinished metal works, metal pouring, noble metals, and the various consumer branches are covered. Long term production conditions, environmental protection, energy costs, and social costs and administrative demands are also considered. Finally, the outlook for the future is given.

A80-44230 \* # JT9D-7A /SP/ jet engine performance deterioration trends. G. P. Richter (NASA, Lewis Research Center, Cleveland, Ohio), W. J. Olsson (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.), and N. B. Andersen (Pan American World Airways, Inc., Kennedy International Airport, N.Y.). Hamilton Burr Publishing Co., International Aircraft Maintenance Engineering Exhibition and Conference, Dallas, Tex., Apr. 8-10, 1980, Paper, 21 p.

It is noted that increasing fuel costs and the decreasing availability of fuel supplies have lead to an increase in the importance of maintaining good specific fuel consumption over the life cycle of jet engines. Attention is given to an engine diagnostics program sponsored by NASA Lewis Research Center which has the objectives of identifying and quantifying the levels, trends, and causes of engine performance deterioration. It is reported that as part of the program, a series of installed engine calibrations were performed on two new Pan American World Airways 747 SP aircraft. A discussion of this specific test program and the results of the analysis of the data are presented.

M.E.P.

A80-44412 # Large advanced waste treatment plants. D. E. Eckmann (Alvord, Burdick, and Howson Engineers, Chicago, III.). (American Society of Civil Engineers, Convention and Exposition, Chicago, III., Oct. 16-20, 1978.) American Society of Civil Engineers. Environmental Engineering Division, Journal, vol. 106, Aug. 1980, p. 840-846.

The advanced waste treatment plant at Roanoke, Virginia is described with attention given to the facilities, the activated sludge process, the nitrification process, the flocculation-coagulation process, filtration, disinfection, sludge, plant effluent, energy requirements, and costs. The Roanoke plant costs about 50% more to construct than a typical activated sludge plant and uses about 60% more energy but discharges an effluent that looks like drinking water

and meets the stringent permit standards established for the plant.

A80-44764 The tax on waste heat An instrument of economic policy for preserving resources (Die Abwärmeabgabe - Ein wirtschaftspolitisches Instrument zur Ressourcenschonung). D. Winje (Berlin, Technische Universität, Berlin, West Germany). Brennstoff-Wärme-Kraft, vol. 32, July 1980, p. 269-272. 11 refs. In German.

An investigation of the district heating potential of the German Federal Republic, especially the question to what extent it can be covered by waste heat from power stations, is presented. Attention is given to energy economical and energy political possibilities which are evaluated according to how they can promote the aim of increasing the proportion of the combined heat and power generation.

M.E.P.

A80-44780 # Setting fire to the whole forest (Faire feu de tout bois). A. Jaumotte. Académie Royale de Belgique, Classe des Sciences, Bulletin, vol. 64, no. 12, 1978, p. 866-878. 10 refs. In French

Belgian energy policy is discussed in light of the recent energy crisis and opposition to nuclear power. The primary sources of the energy consumed by the world are indicated, and arguments against nuclear power and the background of the oil crisis of 1973 are reviewed. The current world energy situation and future supplies and demand are evaluated, and the eventual, inevitable occurrence of a second oil crisis given present policies and patterns of consumption is predicted. Means of preventing such a crisis are then considered, with attention given to adjustments to be made in the ratios of natural gas, coal and nuclear energy consumption and the development of alternative energy supplies. Finally, it is recommended that in Belgium, which must import 86 percent of its energy, future policy must act to encourage conservation, heat recovery and the recovery of wastes and to diversify fuel supplies, including nuclear.

A.L.W.

A80-45300 Environmental control technology for atmospheric carbon dioxide. A. S. Albanese and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). *Energy* (UK), vol. 5, July 1980, p. 641-664. 24 refs.

The paper assesses the impact of fossil-fuel use in the U.S. on worldwide CO2 emissions, along with the impact of increased coal utilization on CO2 emissions, the aspects of CO2 control, and the available control points. The primary factor affecting the practicability of a CO2 control system is the energy required by the control system; of the three control points, removal from the stacks of fossil fuel power plants requires the least amount of energy, and estimates of the energy required to capture and recover CO2 from coal-fired power plant stacks by various processes is presented. Two control schemes are evaluated, one based on the absorption of CO2 contained in power plant flue gas by seawater, and the second based on the absorption of CO2 by monoethanolamine (MEA). The analyses indicate that capture and disposal by seawater is not feasible while disposal by MEA is a possibility, although the costs of CO2 control are significant.

A80-45481 Some etching studies of the microstructure and composition of large aluminosilicate particles in fly ash from

coal-burning power plants. L. D. Hulett and A. J. Weinberger (Oak Ridge National Laboratory, Oak Ridge, Tenn). *Environmental Science and Technology*, vol. 14, Aug. 1980, p. 965-970. 11 refs. Research supported by the Electric Power Research Institute; Contract No. W-7405-eng-26.

An etching method for removing glass phases from the aluminosilicate matrix of fly ash is applied to the study of the morphologies, compositions and distributions of mullite, quartz and glass phases in the aluminosilicate matrix of fly ash particles from coal-burning power plants. Fly ashes from four plants burning East Tennessee and Western Kentucky coal using tangential and cyclone firing were separated by size and characterized by optical and scanning electron microscopy and X-ray diffraction prior to and following HF treatment to selectively dissolve the glass phases. Etching is observed to leave mullite in the acicular and chunky forms and quartz. The acicular mullite is found to have a composition approximating 3(Al2O3)-2(SiO2), with Fe and Ti isomorphically substituted for Al and Si in the mullite. The elements Na, Mg, K and Ca are determined to be totally contained in the glass phases, which are silicon rich and make up over 60% of the aluminosilicate matrix. Results are interpreted to suggest that the surface enrichment of trace elements may result from the diffusion of the elements from inside the particles.

A80-45484 Factors influencing the release of boron from coal ash materials. A. S. Halligan and G. K. Pagenkopf (Montana State University, Bozeman, Mont.). *Environmental Science and Technology*, vol. 14, Aug. 1980, p. 995-998. 21 refs.

Five coal ash materials have been leached with distilled and natural waters. The amount of boron released is dependent upon the contact time, the ratio of ash to leachate water, and ash particle size. When the ratio of ash to water is greater than 1 g/L, the ash is capable of retaining a sizable fraction of the water-available boron. For example, an upper stack ash released 520 micrograms of boron/g when it was leached at a rate of 1 g of ash/L. When the leaching rate was increased to 50 g of ash/L, 318 micrograms of boron/g was released. (Author)

A80-46150 A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area. L. T. Khemani, M. S. Naik, G. A. Momini, A. M. Selvam, B. V. R. Murty (Indian Institute of Tropical Meteorology, Poona, India), and K. S. D. Kachre (Indian Meteorological Department, Poona, India). Water, Air, and Soil Pollution, vol. 13, Sept. 1980, p. 303-316. 23 refs.

A80-46335 Mid-range energy forecasting system - Structure, forecasts, and critique. G. DeSouza. *Energy Systems and Policy*, vol. 4, no. 1-2, 1980, p. 5-24. 17 refs. Research supported by the U.S. Department of Energy.

The Mid-Range Energy Forecasting System (MEFS) is a large-scale, interdisciplinary model of the U.S. energy system maintained by the U.S. Department of Energy. A critical guide of the model's output for potential users is provided in this paper. The model's logic is described, the latest forecasts from MEFS are presented, and the reasonableness of both the forecasts and the methodology are critically evaluated. The manner in which MEFS interfaces with the Oil Market Simulation Model (OMS), which forecasts crude oil price, is also discussed. The present evaluation leads to the conclusion that while there are serious problems with MEFS, it can, when used selectively, be very useful. (Author)

A80-46336 The effect of demand uncertainty on the relative economics of electrical generation technologies with differing lead times. R. Boyd (California, University, Davis, Calif.) and R. Thompson (General Services Administration, Sacramento, Calif.). Energy Systems and Policy, vol. 4, no. 1-2, 1980, p. 99-124. 9 refs.

Projections of the demand for electricity in future time periods are subject to considerable uncertainty. Because the demand for electricity depends on factors such as population and economic growth, the more distant the time period for which the projection is made, the greater is the uncertainty. Thus generation technologies

with different lead times face demand forecasts with different levels of uncertainty. This fact affects the relative economics of generation technologies with differing lead times. In this paper a model is described in which a stylized electric utility faces the decision between a short and a long lead time technology in an uncertain environment. A dynamic programming algorithm is used to determine the least cost investment decision. It is shown that uncertainty can lead to the choice of some short lead time capacity, even when the deterministic solution includes only long lead time capacity. The extent of this effect depends on the nature of the probability distribution of future demands and the relative fuel and capital costs of the two technologies. (Author)

A80-46681 Down to earth operations. Aviation Engineering and Maintenance, vol. 4, Apr. 1980, p. 37-39.

The paper examines cost assessments of current air transport procedures and changes in operational practices to minimize fuel costs. The use of ground power instead of aircraft-mounted auxiliary power units for terminal operations is described which include 30 diesel units which provide compressed air to start turbine engines. Fuel savings can also be made by using fixed, centralized power distribution systems which consist of a power source, a distribution network, service cable storage and handling devices, with converters of 50 Hz utility power to 400 Hz power for the airline terminal. A.T.

A80-47099 Energy choices for the 1980s. D. C. White (MIT, Cambridge, Mass.). *Technology Review*, vol. 82, Aug.-Sept. 1980, p. 30-40.

Energy alternatives for the United States in the coming decade are examined in light of federal policies and the current and projected economic situation. Consideration is given to means of ensuring energy supplies for the short term, the effects of increasing energy prices on inflation and other adverse economic effects, and to means of stimulating changes in energy consumption patterns and technologies to match available energy sources. It is recommended that available energy sources be allocated so that transportation has first priority in the use of liquid fuels, natural gas is devoted chiefly to space heating and industrial uses, coal is used for industrial process heat and some electricity generation, and the remainder of electricity is provided by nuclear and hydro-power. Also the limited appropriateness of renewable resources, and the need for the development of synthetic gaseous and liquid fuel production technologies are pointed out. The possible role of energy conservation is also assessed, and it is concluded that although conservation as well as the development of new technologies will alleviate the energy problem, a major, and timely, transition in total industrial productivity and consumption patterns is required, with prices reflecting true costs.

A80-47585 Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Congress sponsored by the Association of Energy Engineers and U.S. Department of Energy. Atlanta, Ga., Fairmont Press, Inc., 1980. 399 p. \$45.

The conference focused on energy utilization techniques and current technologies applicable within the commercial, industrial, and institutional sectors. Major subjects include energy from refuse, industrial energy utilization, cogeneration and community district heating, energy from wood, new developments in solar power technology, and new approaches to energy management. In addition, recent energy utilization developments in Finland and the United Kingdom are presented.

A80-47586 A synergistic solid waste to energy project - Phase 1 project concept. J. E. Schaeffer (Delaware County, Solid Waste Management, Pa.), S. E. Price (Scott Paper Co., Chester, Pa.), and A. W. Hogeland. In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers.

Atlanta, Ga., Fairmont Press, Inc., 1980, p. 5-8.

A project has been proposed to use the 1500 tons per day of

#### 01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

municipal solid waste available in Delaware County in Pennsylvania for the production of steam and electric power for Scott Paper Company's plant. The project will consist of a facility for combustion of solid waste, including recovery of residual materials, disposal of the remaining ash, and provisions for continuity of operation in the event of interruption in the waste stream or interruption in the use of steam from the project. Major tasks of the project, its economic viability, and synergistic features are briefly reviewed. V.L.

A80-47592 The design, application benefits, and economics of energy-efficient motors - A technological update. J. V. Yu (Gould, Inc., El Monte, Calif.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 147-154.

A80-48199 # Economic performance model of AFBC systems. J. S. Gordon (TRW, Inc., Energy Systems Planning Div., McLean, Va.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 321-329. 8 refs. Research supported by the U.S. Department of Energy.

Three main options are available for the reduction of sulfur oxides in fluidized bed combustion systems: (1) the use of desulfurizing sorbent atmospheric fluidized bed combustion (AFBC) systems to replace inert ash beds, (2) coal beneficiation, and (3) flue-gas desulfurization (FGD). A computer model was used to perform a comparative evaluation of environmentally acceptable powerplant systems which combine these three elements. The results show the extent to which both coal cleaning and FGD act to reduce sorbent consumption in AFBC systems. The cost and energy input increases as coal beneficiation and FGD are increased, the location of the minimum depending on coal properties.

A80-48280 # Industrial energy conservation with the natural gas-fueled molten carbonate fuel cell. R. M. Bowman, B. J. Jody, K. C. Lu, and K. F. Blurton (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 875-880. 5 refs. Research supported by the Gas Research Institute.

A80-48333 # The OASIS computer program for optimization and simulation of integrated systems. D. J. Bingaman, V. A. Rabl, J. M. Calm (Argonne National Laboratory, Argonne, III.), Z. O. Cumali, P. K. Davis, and I. Adler (Consultants Computation Bureau, Oakland, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1227-1232. Research sponsored by the U.S. Department of Energy.

The Integrated Community Energy Systems (ICES) approach offers an opportunity to increase the efficiency of energy production and utilization at the community level. A computer program, OASIS (Optimization and Simulation of Integrated Systems), has been developed to aid in the analysis and design of ICES central plants. The program contains a library of generic equipment routines and has been structured to allow the easy inclusion of component routines which simulate new energy conserving technologies. OASIS simulates plant operation as a quasi-steady state process at discrete time intervals, generally hourly, for periods selected by the user. Operating strategies may be defined by the user or the plant may be simulated to minimize either weighted resource energy consumption or the costs of operation and maintenance.

B.J.

A80-48420 # Design considerations for a near-term hybrid vehicle. R. Schwarz (South Coast Technology, Inc., Santa Barbara, Calif.). In: Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1760-1765.

The paper discusses various aspects of the design of a passenger car with a hybrid electric/heat engine drive train. The basic design goal is to maximize fuel economy in a vehicle whose performance and cost are competitive with conventional cars. It is found that, to meet the performance and cost contraints, a parallel design is required, and the heat engine must be sized to deliver about two-thirds of the maximum vehicle power requirement. A control strategy to maximize the fuel economy of such a parallel hybrid is developed, incorporating three basic elements: net withdrawal of stored battery energy up to a certain battery discharge limit, on/off operation of the heat engine, and control of the power split between the heat engine and electric motor to keep the heat engine operating close to its region of minimum brake specific fuel consumption. The fuel economy gain attainable by a hybrid with such a control strategy is estimated, and implications in other areas, such as emissions, are discussed. (Author)

A80-48426 # An energy and cost analysis of residential heat pumps in northern climates. J. K. Martin and D. L. O'Neal (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1802-1807. 13 refs. Contract No. W-7405-eng-26.

Since 1971, residential heat pump sales have dramatically increased every year. In certain areas of the country, heat pumps account for over 80% of the space heating systems in new housing starts. Penetration in the residential market by heat pumps is beginning to take place in colder areas of the country where heat pumps have traditionally been overlooked. Lack of natural gas and high oil prices, combined with the large energy costs of electric resistance heat have forced renewed attention to the heat pump in colder climates. This paper examines the diversity in heating energy use and cost effectiveness of forty-one currently retailed heat pumps in three northern cities: Boston, Denver, and Minneapolis. Heat pump heating energy use and annualized life-cycle costs are compared with other forms of space heating equipment in those same cities. (Author)

A80-48514 # Energy conservation measures for commercial buildings used in life cycle cost analysis. J. J. Deringer (Gilford, Deringer and Co., Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2350-2355.

The procedures and summary results of a detailed life cycle cost analysis of three recent office building designs are described. The analysis was conducted as part of the Energy Performance Standards for New Buildings Program (BEPS). The analysis results to date, while limited as indicated, show that, (60% to 70% reduction) significant energy reduction from recent practice are possible. While construction costs do not increase for some design solutions, typically construction costs increased in the range of 8% to 12% for many solutions in comparison with recent practice. Further, many of the design solutions achieving significant energy savings also achieved life cycle cost reductions in the range of 5% to 15% when compared with recent practice. The effectiveness of specific energy conserving strategies for the envelope, HVAC systems and lighting are discussed.

#### 01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

A80-48515 # Life cycle cost analysis in residential buildings and consumer appliances. M. Levine, D. Goldstein, I. Turiel, H. Herring, and H. Estrada (California, University, Berkeley, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2356-2362. 13 refs.

This paper outlines how life-cycle costing can be applied to an analysis of energy conservation measures in residential buildings and consumer appliances. Results are presented from our work on the life-cycle costs for the Building Energy Performance Standards and the Consumer Products Energy Performance Standards of the U.S. Department of Energy. These sample results, for a single story detached house heated with gas and for room and central air conditioners, show that a minimum in life-cycle costs is achieved for increasing conservation measures.

(Author)

A80-48533 Sulfate aerosol production and growth in coal-operated power plant plumes. A. C. Dittenhoefer and R. G. de Pena (Pennsylvania State University, University Park, Pa.). (Symposium on Budget and Cycles of Trace Gases and Aerosols in the Atmosphere, Boulder, Colo., Aug. 12-18, 1979.) Journal of Geophysical Research, vol. 85, Aug. 20, 1980, p. 4499-4506. 28 refs. Contract No. E(11-1)-2463.

The oxidation of SO2 and the resultant aerosol growth kinetics are inferred from airborne measurements of the number concentrations and size distributions of pure sulfate and mixed particles within the coal-fired Keystone power plant plume in western Pennsylvania. Measurements of aerosol concentrations in nine distinct size ranges between 0.01-2.0 micron diameter were coupled with impactor sampling and quantitative sulfate analysis of individual particles at various plume travel times. Cross-sectional plume mappings of the horizontal and vertical concentration profiles of SO2 and sulfate mass provided a means of calculating SO2 conversion rates. Thirteen flights encompassing a wide range of meteorological conditions and plume behavior were compared in an attempt to isolate the various gas-to-particle conversion mechanisms. Both gas and droplet phase reactions involving SO2 have been identified, and their importance for atmospheric sulfate formation are assessed. Total sulfate particle concentration was found to be related directly to solar radiative flux. Sulfate particles in the plume achieved maximum size at very high relative humidities during plume merger with cloud and fog layers.

(Author)

A80-48534 Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes. F. P. Parungo and R. F. Pueschel (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). (Symposium on Budget and Cycles of Trace Gases and Aerosols in the Atmosphere, Boulder, Colo., Aug. 12-18, 1979.) Journal of Geophysical Research, vol. 85, Aug. 20, 1980, p. 4507-4511. 6 refs.

An instrumented aircraft was used to survey the plume constituents of oil refineries in southern Los Angeles. Concentrations of NO, NO2, O3, Aitken nuclei, and aerosol size distribution were measured continuously in situ. Aerosols were collected with an impactor and were later analyzed with an electron microscope for particle morphology and chemical composition. The results led to the following conclusions: (1) The refineries are a strong source of NO; as the plume travels, NO reacts with entrained O3 to form NO2 and subsequently converts to nitrate particles. (2) Diurnal variations in NO, NO2, O3 concentrations are directly correlated with solar radiation. In nocturnal stable conditions, NO concentration is as high as 0.7 ppm in the plume. NO2 is low, and O3 approaches nil. After sunrise, NO decreases, and NO2 and O3 increases. (3) Inorganic nitrate particles, which can be identified with an electron microscopic spot test, are found farther downwind of the refineries. They are observed as particles imbedded in droplets with diameters between 1 and 10 microns. (4) Because these large nitrate particles are hygroscopic, they can serve as cloud condensation nuclei to form large cloud droplets and enhance droplet coalescence. Thus they play

very important roles in the processes of cloud formation and precipitation. (Author)

A80-49025 Social acceptance of energy systems. Some observations on the situation in the Third World (L'acceptation sociale des systèmes énergétiques. Quelques observations sur la situation dans le Tiers monde). D. R. Pendse. I Forum Scientifique International sur l'Energie pour les Pays Développés et les Pays en Développement, Nice, France, Oct. 29-Nov. 2, 1979.) Revue de l'Energie, vol. 31, June-July 1980, p. 330-340. 8 refs. In French.

The social acceptance of present and future energy systems in the Third World is discussed based on the present situation in India. The current suboptimal energy system of India is examined, with attention given to desires to reduce energy imports and the effects this would have on the transportation and domestic sectors, and the real costs of energy in Third World nations as exemplified by India are examined. The desires of people living in Third World nations to obtain the energy systems of the rest of the world are considered, and predictions of the world energy situation in the year 2000 are presented in the areas of fossil fuel consumption, economic development and the elimination of poverty, and political institutions. Possibilities for international cooperation in finding solutions to problems of energy supply in both the industrialized and developing nations are considered, and it is concluded that coherent energy policy based on the various aspects of the problem in all nations in necessary.

A80-49391 Investing in coal. J. D. Emerson and V. Clarco (Chase Manhattan Bank, New York, N.Y.). Revue de l'Energie, vol. 31, Aug.-Sept. 1980, p. 7-14. In English and French.

It is predicted that the 1980s are likely to see a reversal of the fortunes of the coal industry. After declining for much of the post World War II period, coal will increase its share of world energy supplies. It is suggested that meeting the goals implicit in this new role will be expensive by past standards in the coal industry, but not unduly expensive by comparison with the investment needs of the other energy industries.

A80-49392 Financing of renewable energy sources /solar, wind and biomass energy sources/. M. Fansten (Commissariat à l'Energie Solaire, Paris, France). Revue de l'Energie, vol. 31, Aug. Sept. 1980, p. 32-42. In English and French.

The financing of renewable energy sources is discussed with reference to research and experimentation, and market development. Particular attention is given to the cost of renewable energy, curbs on market development, obstacles to solar energy development, the incentives for solar heating in France, and new energies and job creation.

B.J.

A80-49393 Capital requirements for energy in the industrialised countries. P. Tempest. Revue de l'Energie, vol. 31, Aug. Sept. 1980, p. 43-52. 14 refs. In English and French.

Various key factors which will determine the capital requirements for energy of the industrialized countries over the next two decades are reviewed. Attention is given to capital market sources, the implications of differing energy requirements, the economic constraints of growth, the danger of persistent low growth, attempts to counteract discontinuity, energy pricing discrepancies, conservation as a part of energy investment, and technological constraints in new energy.

B.J.

A80-49394 Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties. C. Beaucourt. *Revue de l'Energie*, vol. 31, Aug.-Sept. 1980, p. 53-70. 43 refs. In English and French.

Certain aspects of capital requirements for energy development in the Soviet Union and Eastern Europe are reviewed. Particular attention is given to the impact of fuel policy on investments, the changing and developing needs in the energy sector, and economic

options and their impact on the development of energy sources and capital requirements.

A80-49395 Financing of energy investments - Capital and policy requirements of developing countries. B. Chadenet and Y. Rovani (International Bank for Reconstruction and Development, Washington, D.C.). Revue de l'Energie, vol. 31, Aug. Sept. 1980, p. 71-85. In English and French.

The paper considers the energy potential and the financial needs of developing countries, and examines energy planning and policy decisions that may solve the energy problems of such countries. It is noted that many developing countries face a dual energy crisis: a serious gap in the balance of payments and an overconsumption of biomass resources. In order to solve this dual crisis developing countries must develop by priority their own resources.

B.J.

A80-49396 The economics of energy prices - Doubts and uncertainty. V. Levy-Garboua. Revue de l'Energie, vol. 31, Aug. Sept. 1980, p. 86-99. In English and French.

An explanation of energy costs is sought in an analysis of the factors that determine supply and demand in this sector. This analysis is then used to reflect on the role of energy price policy, its principles and end purposes.

B.J.

A80-49397 Assessment of risks in the financing of major energy projects. J. Gabriel and A. Galibert (Société de Promotion des Grands Projets Internationaux, France). Revue de l'Energie, vol. 31, Aug. Sept. 1980, p. 113-126. In English and French.

The various types of risks associated with the financing of a major energy project are reviewed, including: (1) the construction period risks, (2) the risks at the time of delivery of the facilities, and (3) the operating period risks (particularly those during the debt repayment period). Consideration is then given to the limitation and spreading of risks, and to direct and indirect securities. It is concluded that, in comparison with the traditional financing of industrial projects, large energy projects will increasingly necessitate a thoroughgoing change in the evaluation of risks and the customary methods of covering the risks.

A80-49398 Trends in financing LNG projects. W. Dorson (Chase Manhattan Bank, New York; N.Y.). Revue de l'Energie, vol. 31, Aug.-Sept. 1980, p. 145-150. In English and French.

The capital costs required for a base load LNG (liquefied natural gas) project have increased dramatically over the past decade. Compared to the scope and cost of earlier projects capital requirements have increased beyond the investment appetites of most private investors and financing responsibility tended to become segmented in a manner reflecting specific responsibilities. It is suggested that through the use of a project financing approach it may be possible to disaggregate certain project responsibilities based on the changing motivations and expertise of interested parties. This approach may provide some of the answers required to ensure the financial viability of many proposed LNG projects.

B.J.

A80-49399 The investment needs of the coal industry of the European Community. A. Woronoff (Comité d'Etude des Producteurs de Charbon d'Europe Occidentale, Brussels, Belgium). Revue de l'Energie, vol. 31, Aug. Sept. 1980, p. 180-192. In English and French.

The situation in the main coal-producing countries (i.e., Germany, the United Kingdom, France, and Belgium) of the European Economic Community is reviewed. It is suggested that the achievement of a coal-production objective for the Community of about 270 million tonnes will require an annual level of investment in new and existing mines of some 2.3 billion EUA at constant prices. It is noted that the universally recognized need to face up to a growing level of demand requires an investment program on the part of the European coal industry of a totally different order from that achieved during the last two decades.

A80-49400 Financing for energy resources development projects - Japanese experience. H. Ishihara (Industrial Bank of Japan, Ltd., Tokyo, Japan). Revue de l'Energie, vol. 31, Aug. Sept. 1980, p. 203-222. In English and French.

The past energy demand situation and the future outlook in Japan are reviewed. Consideration is then given to the overall financing aspects of past energy resources development projects. Finally, the institutional aspects of the financing and of the problems involved are discussed.

B.J.

A80-49648 Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost. C. Komanoff (Komanoff Energy Associates, New York, N.Y.). Air Pollution Control Association, Journal, vol. 30, Sept. 1980, p. 1051-1057, 20 refs.

The reductions in air pollutant emissions achieved by pollution control improvements in coal-fired electric generating plants and the costs of such improvements are discussed. It is shown that the enactment of New Source Performance Standards for new coal plants enacted in 1971 by the U.S. Environmental Protection Agency led to decreases up to 64% in sulfur dioxide, particulate and nitrogen oxide emissions from coal plants completed in 1978 relative to those from 1971 plants, at a cost accounting for 90% of the 68% increase seen in constant-dollar power plant costs. The more stringent emissions standards for plants coming into service in the 1980s are discussed, and the costs of implementing additional pollution controls to comply with these standards are estimated at \$190/kW, or an additional 36%. The possible impacts on cost and pollution emissions of the prospective techniques of fluidized bed combustion and coal cleaning are indicated. A.L.W.

A80-49695 Energy conservation in terminal airspace through fuel consumption modeling. D. E. Winer and C. J. Hoch (FAA, Office of Environment and Energy, Washington, D.C.). Society of Automotive Engineers, International Air Transportation Meeting, Cincinnati, Ohio, May 20-22, 1980, Paper 800745. 10 p. 11 refs.

Mathematical models are being developed by the Federal Aviation Administration to determine aircraft fuel consumption under a wide variety of operational conditions. These models are particularly needed to determine the effects of proposed changes to air traffic procedures. The models are described and examples are given for their use by analysts and policymakers. (Author)

A80-49728 Impact of electric cars on national energy consumption. P. D. Agarwal (GM Research Laboratories, Warren, Mich.). Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800111. 7 p. 15 refs.

Energy utilization of electric vehicles is discussed in terms of energy efficiency in comparison to internal combustion engine automobiles, starting from oil or coal as the prime energy source. It is found that although an electric car does not save primary energy resources, it can transfer some of the transportation fuel needs from petroleum to coal, nuclear, or hydropower. With reference to the impact of electric vehicles on reduction of petroleum consumption, it is shown that the dependence of the United States on foreign oil can be reduced much more quickly and at much lower cost by converting electric utility boilers from oil to coal.

V.L.

A80-49929 State and tendencies of recycling in North America. J. G. Abert (National Center for Resource Recovery, Washington, D.C.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 18-25. 9 refs.

Although the subject of this paper is resource recovery in North America, by and large, the text describes resource recovery activity in the United States where there are many more examples of project implementation than in Canada. The paper begins with a waste

#### 01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

composition analysis and then presents some data relating waste recycling to energy savings in materials processing and the energy created by combustion of waste as an alternative fuel source. Next, a table is presented which is a comprehensive listing of United States recycling projects. United States government policy related to resource recovery is discussed in the next section, followed by a look into the future in the concluding section of the paper. (Author)

A80-49931 An analysis of criteria for evaluating proposals for recovery of material and energy from refuse. F. P. Gross (Massachusetts Bureau of Solid Waste Disposal, Boston, Mass.) and J. Kühner (Meta Systems, Inc., Cambridge, Mass.). In: Recycling Berlin 79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 32-37.

Numerous political jurisdictions throughout the world are currently involved in the procurement of facilities for the recovery of materials and energy from refuse. This paper presents an analysis of evaluation criteria that can be used in a competitive bid framework to facilitate the decision on the most suitable refuse treatment methods, processes, and contractors. Attention is given to criteria relating to process design, cost and pricing, qualifications and management plan, and environmental impact.

A80-49932 Steps to system analysis in waste management. K. A. Wuhrmann (Zürich, Eidgenössische Technische Hochschule, Dübendorf, Switzerland). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 38-43.

It is shown that the decision process relating to future waste management systems is hampered by future uncertainty and the incompatibility of several system parameters. The relevant parameters for the decision process are discussed in terms of cost-benefit analysis, ecologically quantifiable values, and ideal values.

B.J.

A80-49933 The efficiency of recovering energy and materials from solid waste. D. C. Wilson (Atomic Energy Research Establishment, Harwell Laboratory, Harwell, Oxon, England). In: Recycling Berlin '79: Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 44-49. 8 refs.

Two measures (alpha and beta) of the energy efficiency of a waste disposal, treatment, or recovery process have been developed which relate the amount by which the stock of primary energy is augmented to the heat content of the waste. The use of primary energy ensures that both direct and indirect energy are included. The two efficiency measures differ in that alpha includes only energy savings due to fuel products, whereas beta also considers energy savings due to recycled materials. The net primary energy efficiency beta provides a single quantitative measure of the resource conservation potential of a process and is thus particularly useful to the planner in selecting the best option for his local needs.

A80-49934 Application of the energy concept to a resource recovery system. S. Otoma and S. Gotoh (National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 50-55.

Exergy is used to characterize the energy availability of a resource recovery system. It is shown that a waste processing system can be interpreted in terms of two exergy-based efficiencies: one is a measure of pollution control while the other is a measure of the degree of energy recovery with respect to the system environment. A pyrolysis process is used as an example.

B.J.

A80-49939 Anatomy of regional solid waste resource recovery projects. L. O. Ward and R. J. Schoenenberger (UOP, Inc.,

Des Plaines, III.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 89-95.

The paper analyzes legal, financing, political, economic, technical, and environmental aspects of planning regional 3000-ton solid waste recovery projects. Facility capacities, number of combustion trains, and turbine-generator capacity, and costs of different designs were evaluated, noting that the principal problems in implementation of a project have been financing, legal, and risk considerations that may be experienced during the next 30 years. A successful solid waste recovery project requires an assured solid waste supply, a publicly acceptable site, reliable energy customers, and technological-management capability. Qualified engineering-consulting firms, financial and legal advisors, and cooperation of government agencies are necessary to construct a solid waste plant.

A80-49954 Environmental impact of conversion of refuse to energy. R. A. Olexsey (U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Cincinnati, Ohio). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 281-288. 10 refs.

Air and water pollution problems associated with the conversion of solid waste to energy are discussed together with applicable control technology. Combustion, pyrolysis, and biological processes are examined. From currently available data, it is concluded that control of particulate emissions, preferably through a fabric filter or an electrostatic precipitator, is the only air pollution control requirement to ensure compliance with existing Federal Stationary Source Performance Standards. It is also shown that some form of conventional treatment of liquid effluents should be able to handle discharges from waste-as-fuel operations.

A80-49958 Energy savings in a rotary kiln in the production of cement through the addition of domestic waste and sewage sludge. P. C. Nüesch and H. Künstler (Küpat AG, Uitikon-Waldegg, Switzerland). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 318-323.

A80-49961 The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants (Vorteile der Verwendung eines Verbrennungssteuerungs-Systems zur Regulierung der Emissionen schädlicher Gase sowie der Dampferzeugung in Müllverbrennungsanlagen). S. Kitami (Mitsubishi Heavy Industries, Ltd., Yokohama, Kanagawa, Japan) and S. Okuno. In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 411-418. In German.

A control system for maximizing reclamation of heat in incinerators is investigated. The production of toxic gases is to be limited also, and emission standards of 430 ppm HCl and 250 NO(x) must be met with 12 percent O2 content. The amount of these gases emitted is closely associated with variations in refuse incineration, therefore substantiating the need for a control system. A continuous control loop was investigated with an analog computer, along with an on/off control circuit (using relays, with or without feedback compensation). The feedback component improves the quality of control substantially in an on/off control. Continuous feedback compensation is the best controller if a manipulated variable is a good continuous function.

A80-49968 Effluent-free flue gas scrubbing process to separate the fine dust and the noxious gases from waste combustion

plants. V. Fattinger (Ciba - Geigy AG, Schweizerhalle, Switzerland). In: Recycling Berlin '79: Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 467-472. 6 refs.

A80-50528 Sulfate in diesel exhaust. T. J. Truex, W. R. Pierson, and D. E. McKee (Ford Motor Co., Dearborn, Mich.). Environmental Science and Technology, vol. 14, Sept. 1980, p. 1118-1121, 33 refs.

A study of sulfate emissions from diesel-powered light-duty vehicles has been conducted. The applicability of a controlled-condensation sampling procedure for determining the chemical speciation of vehicle sulfate emissions has been demonstrated and used to determine that sulfuric acid is the major sulfate species present in diesel exhaust. Diesel sulfate emissions were found not to be proportional to fuel sulfur level, the percent S to SO4(2-) conversion increasing as fuel sulfur level decreases. An Opel diesel vehicle was equipped with an experimental oxidation catalyst to determine the effect on diesel sulfate emissions. (Author)

A80-50818 Possible means of cutting energy costs and saving primary energy in waste water purification (Möglichkeiten zur Verringerung der Energiekosten und Einsparung von Primärenergie bei der Abwasserbehandlung). E. Klauwer and H.-G. Rumpf (Rheinisch-Westfälische Elektrizitätswerke AG, Essen, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 372-378. 12 refs. In German.

A historical review of waste water purification technology is followed by an assessment of the power requirements of biological purification. In view of these substantial requirements, some considerations are set forth concerning the optimal use of sewer gas (methane) for generating the power required by a large biological purification plant. The engineering and economic aspects of three model concepts are discussed.

V.P.

A80-50819 Energy expenditure for environmental protection - A contribution to efficiency analysis (Energieaufwand im Umweltschutz - Ein Beitrag zur Effizienzbetrachtung). K. Repenning (Deutsche BP AG, Hamburg, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 378-380. 8 refs. In German.

The considerations set forth in the present paper lead to the conclusion that in future discussions aimed at protecting the environment, the specific energy consumption involved in each desired means of protection must be given careful and detailed consideration. Increased attention should be given to the power aspects of any planned environmental protection projects.

A80-50820 An attempt at balancing the environmental effects of electric power generation with the framework of the country's economic system (Versuch einer Bilanzierung der Umwelteinflüsse der Elektrizitätswirtschaft im Rahmen des gesamtwirtschaftlichen Systems). H. Trenkler (Vereinigung Deutscher Elektrizitätswerke AG, Frankfurt am Main, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 380-385. 16 refs. In German.

The effects of electric power generating facilities on the environment in a densely populated area, such as the German Federal Republic, are demonstrated. Their relationship to other environmental effects produced by energy release is examined. V.P.

A80-50821 The significance of the gas economy from the viewpoint of environmental protection (Die Bedeutung der Gaswirtschaft aus der Sicht des Umweltschutzes). D. Ewringmann and F. Vorholz (Köln, Universität, Cologne, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 386-393. In German.

An attempt is made to put the economic significance of natural gas as an energy source in proper perspective. The extremely small contribution of natural gas, as compared to other energy sources, to air pollution is pointed out, and the effects of emission and heat

release on the environment are studied. The size of natural gas resources, and the substitution potential of natural gas are discussed.

V.P.

A80-50822 The CO2 problem from the viewpoint of geoecology and energy economy (Die CO2-Frage aus geoökologischer und energiewirtschaftlicher Sicht). H. Lieth (Osnabrück, Universität, Osnabrück, West Germany), J. Seeliger, and G. Zimmermeyer (Gesamtverband des Deutschen Steinkohlenbergbaus, Essen, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 393-400. 43 refs. In German.

The observed annual increase in atmospheric CO2 content by approximately 1 ppm CO2 is usually attributed to the combustion products of fossil fuels. In the present paper, the current (international) status of the CO2 problem is reviewed, and the relation between CO2, the biosphere, and climatology is studied. Some energy economy implications are examined.

V.P.

A80-50824 Provision of electric power as a prerequisite and determining factor for safeguarding the industrial community and ensuring the economical development of the Third World (Die Bereitstellung elektrischer Energie als Voraussetzung und Bestimmungsfaktor für die Sicherung der Industriegesellschaft und die wirtschaftliche Entwicklung der Dritten Welt). H. Boeck (Stadtwerke Hannover AG; Vereinigung Deutscher Elektrizitätswerke, Hanover, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 410-415. In German.

A80-50825 Ensured power supply and environmental protection as elements of a provident social policy (Sicherheit der Energieversorgung und Schutz der Umwelt- Elemente vorsorgender Gesellschaftspolitik). G. Hartkopf (Bundesministerium des Innern, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 415-419. In German.

The conflict situation between the industry and environmental protection, which has developed in post-war Germany is examined in the light of the current governmental approach to the power supply problem. Means of resolving the principal problem areas are discussed.

V.P.

A80-50826 Increased information acquisition and transmission as a condition for the further development of energy economy structures (Wissenszuwachs und Wissensweitergabe - Eine Bedingung für die Fortentwicklung energiewirtschaftlicher Strukturen). P. Schnell and M. Dehli (Energie-Versorgung Schwaben AG, Stuttgart, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 419-424. 15 refs. In German.

The world-wide energy supply suffers currently from the limited availability of potential energy sources, and a remedy in this situation is possible only by combining an increased research effort with an adequate information service. Some aspects of the energy data acquisition and transmission are discussed, and the need to include politics, education, and international cooperation in this effort is noted.

V.P.

A80-50827 The investment demand of energy economy and its financing (Der Investitionsbedarf der Energiewirtschaft und seine Finanzierung). R. Diel, G. Radtke, and R. Stössel (Dresdner Bank AG, Düsseldorf, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 445-452. In German.

The demand for investment to cover energy requirements is studied primarily from the West German but also to some degree from the international point of view. Possible economically sound means of financing the investment demand are examined. The investments and capital demand for fossil energy sources, in the energy economy, and for regenerative energy sources, such as solar, wind, and tidal energy are studied.

A80-50944 Performance monitoring of low energy house, Macclesfield. F. R. Stephen (Electricity Council, Research Centre,

#### 01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

Capenhurst, Ches., England). International Journal of Ambient Energy, vol. 1, Jan. 1980, p. 29-46. Research supported by the Electricity Council.

The monitoring of the energy balance of a very well insulated low-energy house in Macclesfield, England is discussed. The house is an existing dwelling which had been converted into a low-energyrequiring house by the reduction of heat loss through a high level of thermal insulation and the collection of solar energy by a water cascade solar panel with warm water storage. Measurements of house temperatures, radiation, off-peak electricity consumption and hot water and heating using were performed from January to August, 1978 and reveal that the house used less than 22,000 kWh electricity during that period, compared to 55,000 kWh expected if the house had been constructed to average insulation levels. Solar energy is found to contribute only 2% of house energy requirements, with the use of a heat pump combined with the solar panel leading to greater efficiency and thus utilization. In addition, the large thermal mass and good insulation are found to improve comfort by reducing temperature fluctuations, and the ventilation and low-temperature water return system employed provided satisfactory results. A.L.W.

A80-51202 Second law analysis of energy devices and processes; Proceedings of the Workshop, George Washington University, Washington, D.C., August 14-16, 1979. Workshop sponsored by the U.S. Department of Energy; Contract No. ET-78-G-01-3281. Edited by A. B. Cambel and G. A. Heffernan (George Washington University, Washington, D.C.). Energy (UK), vol. 5, Aug.-Sept. 1980. 452 p.

International progress in second law analysis is reviewed, along with applications of the second law of thermodynamics in the fields of space heating and cooling, energy conservation and coal gasification processes. Some papers deal with the use of second law analysis of chemical process systems and other industrial processes, including controlled fusion research.

V.P.

A80-51500 Optimization problems of emission reduction in large fossil-fuel combustion facilities (Betriebliche Optimierungsprobleme einer Emissionsminderung bei fossil befeuerten Grossfeuerungsanlagen). O. Rentz (Karlsruhe, Universität, Karlsruhe, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Aug. 1980, p. 316-323, 32 refs. In German.

Optimization problems involved in the implementation of emission control in combustion plants are discussed. Separation systems for dust, SO2, and NO(X) are investigated along with planning and operational tolerance in desulfurization plants. The relation between emission reduction and cost minimization planning is described in the case of optimal load distribution. R.C.

A80-51660 Formation of sulfate particles in the plume of the Four Corners Power Plant. Y. Mamane (Technion - Israel Institute of Technology, Haifa, Israel) and R. F. Pueschel (NOAA, Atmospheric Physics and Chemistry Laboratory, Boulder, Colo.). Journal of Applied Meteorology, vol. 19, July 1980, p. 779-790. 19 refs. Research supported by the U.S. Environmental Protection Agency.

A80-51933 Energy choices and environmental constraints.
L. B. Cahill, R. W. Kane, and H. L. Burns (Booz, Allen, and Hamilton, Inc., Bethesda, Md.). In: A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 2-21 to 2-30. 9 refs.

The paper reviews the environmental problems associated with two distinct classes of emerging energy technologies, solar and synfuels. Although the recent push towards synfuels has raised serious environmental concerns, it will be shown that developing the 'clean' solar technologies also will demand sound environmental management practices. While changes in technology-use projections based on environmental constraints are not developed in this paper,

it will be seen that some impacts could be quite significant; and still others could very well be 'show-stoppers'. Finally, the Federal regulatory scene is reviewed to determine what steps are being taken to prevent environmental damage without unnecessarily constraining development of new energy technologies. (Author)

A80-51954

TIDP - Basic research for answering Florida's residential energy conservation questions. R. J. Pozzo (Eland Technical Services Corp., Rockledge, Fla.) and D. B. Wiggins (Florida, University, Gainesville, Fla.). In: A new era in technology; Proceedings of the Seventeeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980.

Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 6-59 to 6-64.

The paper describes the Florida Residential Conservation Service (RCS) program for efficient utilization of energy and reducing its use. The program considered energy conservation methods including attic ventilation problems, heating and cooling equipment, roof and wall insulation, and effects of concrete blocks. Devices for energy saving such as half-wave rectifiers, water sprays on air conditioning condensers, and light dimmers were examined; various types of structures exemplified by concrete block construction, solar houses, and mobile homes were analyzed. It was concluded that implementation of the RCS program will produce energy savings and building improvements by developing a clearing house for energy related equipment and designing an energy-efficient state of the art house.

A.T.

A80-52968 The push-pull test - A method of evaluating formation adsorption parameters for predicting the environmental effects on in-situ coal gasification and uranium recovery. J. I. Drever (In-Situ Consulting, Inc., Laramie, Wyo.) and C. R. McKee (Wyoming, University, Laramie, Wyo.). In Situ, vol. 4, no. 3, 1980, p. 181-206. 7 refs. Research supported by the U.S. Department of Energy and University of Wyoming.

Two field push-pull tests were conducted on uranium formations in Wyoming. Adsorption properties estimated from these tests on the basis of a simple cell model are compared to the laboratory values. The laboratory measurement techniques are briefly described for both uranium and coal. In the first case, excellent agreement is observed between the estimated field test values and values measured in the laboratory. In the second case, the value for the distribution coefficient determined in the laboratory is five times higher than the field value. However, no examples are available from coal properties, and it is concluded that coal adsorption measurements present the greatest uncertainty owing to a lack of knowledge concerning the actual in-situ area exposed to fluids. The method described permits prediction of restoration from both in-situ coal gasification and in-situ uranium extraction.

A80-53084 Application of the lime/limestone flue gas desulfurization process to smelter gases. E. Bakke (Peabody Process Systems, Inc., Stamford, Conn.). Air Pollution Control Association, Journal, vol. 30, Oct. 1980, p. 1157-1160.

A80-53687 Environmental concerns for OTEC identified in the DOE OTEC Environmental Readiness Document. K. F. Haven (California, University, Berkeley, Calif.). In: Marine technology. 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 326-330.

The findings of the DOE Environmental Readiness Document (ERD) for OTEC are presented. Nine environmental concerns are identified for OTEC in the ERD; six of the nine concerns represent known environmental hazards, but additional environmental research will be required for each in order to determine both their magnitude and their significance in the open ocean environment. The general conclusion of the ERD is that there appears to be sufficient time to study the potential environmental impacts of OTEC and to apply appropriate control or mitigation strategies without serious disruption to existing commercialization schedules.

A80-53689 1979 status of the OTEC Environment Program. P. Wilde (California, University, Berkeley, Calif.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 340-345. 9 refs.

Preliminary surveys and laboratory studies are being conducted in the waters of Puerto Rico, the Gulf of Mexico, and Hawaii for moored or seacoast OTEC plants and in the equatorial South Atlantic for plant-ship operations to provide baseline data. These data plus existing archival information can be used to model effects of OTEC operations. Four major areas of concern, (1) redistribution of oceanic properties, (2) chemical pollution, (3) structural effects, and (4) socio-legal-economic, and 11 key issues associated with OTEC operation have been identified. Mitigating strategies can be used to alleviate many deleterious environmental effects of operational problems as biostimulation, outgassing, etc. Various assessment research studies on toxicity, biocide releases, etc., are under way to investigate areas where no clear mitigating strategy is available. Data from these programs is being integrated into a series of environmental compliance documents including a programmatic environmental impact assessment. (Author)

A80-54035 Energy models as a tool for planning (Energiemodelle als Planungshilfen). G. Egberts, W. Lenhardt, and W. Terhorst (Kernforschungsanlage Jülich GmbH, Jülich, West Germany). Erdől und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie, vol. 33, Sept. 1980, p. 420-425. 8 refs. In German.

The development of comprehensive energy models is fostered by the increasing complexity of energy maintenance. The structure of the Jülicher energy model (JES) is presented. It is divided into three sections, a data base, a method base and the model system in a modular arrangement. The coupling of the dynamic simulation model with the data and method bases is possible through the interactive Daimos (Data Interface for Modular Simulation) software system, which permits a flexible use of data, methods and models. Mostly statistical data and suitable methods of trend analysis and correlation analysis are available for processing inside the method base. The procedures make use of the Ireca (Interface for Regression and Correlation Analysis) software system. The main part of the JES is a long term energy simulation system. Reciprocal communication between the decision representative and the model builder promotes the successful use of the system.

#### N80-28488# Los Alamos Scientific Lab., N. Mex. TRACE ELEMENT CHARACTERIZATION OF COAL WASTES Annual Progress Report, 1 Oct. 1977 - 30 Sep. 1978

E. M. Wewerka, J. M. Williams, L. E. Wangen, J. P. Bertino, and P. L. Wanek Jun. 1979 94 p refs Sponsored by EPA and DOE

(PB80-166150; LA-7831-PR; EPA-600/7-79-144; AR-3) Avail: NTIS HC A05/MF A01 CSCL 07D

The efficacy of several control options to treat coal wastes at the preparation plant or during disposal was investigated. The research revealed that calcining is one of the more effective and permanent means of treating high sulfur coal wastes before disposal to decrease, quite dramatically, the release of environmentally undesirable pollutants into the drainages from disposal sites. Co-disposal of the coal wastes with lime or limestone to neutralize the acid drainage and contain soluble aqueous contaminants within the waste site is also a promising control. Other experiments examined the feasibility of using natural sealants (e.g., clays, soils, calcite, and cements) to isolate the disposal site from its immediate environment. Various trade offs for these control options are discussed in terms of contaminant reduction, complexity, permanency, and cost.

N80-28557# Princeton Univ., N. J. Dept. of Mechanical and Aerospace Engineering. FORMATION AND CONTROL OF FUEL-NITROGEN POL-LUTANTS IN CATALYTIC COMBUSTION OF COAL-

DERIVED GASES Quarterly Technical Progress Report, 15 Mar. - 15 Jun. 1979

F. V. Bracco, C. Bruno, D. A. Santavicca, J. H. Semler, and P. M. Walsh 1 Jul. 1979 53 p refs (Contract EF-77-S-01-2762)

(FE-2762-8) Avail: NTIS HC A04/MF A01

A review was made of the available data on amounts of nitrogen containing impurities present in coal derived low and medium Btu gases. A summary was made of the most complete of the existing models for catalytic combustor operation. A summary of the theoretical and experimental work on ammonia conversion to NO sub x in catalytic combustion of low and medium-Btu gases is given in this report. Experimental investigations were made of carbon monoxide and medium Btu gas combustion in the presence of platinum supported on a monolithic Cordierite substrate. Axial profiles substrate temperature, gas temperature, and stable species concentrations were measured at different gas velocities and equivalence ratios. Computed axial and radial gas temperature and carbon monoxide concentration profiles inside a catalyst channel during carbon monoxide combustion are presented. The integrated carbon monoxide profiles at the catalyst outlet are compared with the experimentally measured values. A possible approach to minimizing ammonia to SO/sub x/ conversion in catalytic combustion of coal derived gases is presented.

N80-28856# Varigas Research, Inc., Timonium, Md. COMPARATIVE STUDY OF THE ENERGY CHARACTERIS-TICS OF POWERED HAND TOOLS. PART 2: INVESTIGA-**TION REPORTS Final Report** 

[1980] 254 p

(Contract EY-77-C-03-1731)

(SAN/1731-T2) Avail: NTIS HC A12/MF A01

The results of a theoretical analysis and a field test program to determine the relative energy efficiencies of different types of powered hand tools are presented. Grinders, drills, and nutrunners powered by hydraulic fluid, compressed air, 60 Hz single phase electricity, three phase 180 Hz electricity, three phase 360 Hz electricity, and in the case of flexible shaft tools, three phase 60 Hz power were analyzed and tested. The work included the determination of the energy use of the total system including air compressors and frequency converters where appropriate. Distribution system losses were also considered. Pneumatic tools, the most popular tools in industry, were found to use between five and fifteen times more energy than the various electrically powered tools, to do the same work.

N80-28857# Gulf Research and Development Co., Pittsburgh,

REFINERY ENERGY PROFILE Final Report

R. W. Maier, W. P. Olivent, D. L. Brandt, and T. G. Golden Jan. 1979 301 p

(Contracts DE-AC05-77CS-05262; EY-77-C-05-5262) (ORO-5262-5-Suppl) Avail: NTIS HC A14/MF A01

A technique for preparing energy profiles at any refinery was developed. Analysis of Gulf's Alliance refinery profiles showed that about 75% of the energy leaving the refinery was lost from two areas: heater stacks (25%) and air and waster cooled heat exchangers (50%). Further analysis led to estimates of the amount of energy potentially recoverable from these two areas. Totalrefinery energy consumption would be cut up to 6% if all heaters could be economically modified using existing technology to operate at arbitrarily selected control points of 10% excess air and 350 F stack temperature. Comsumption would be cut up to another 19% if technology could be developed to economically recover all heat currently being rejected above 200 F in air and water cooled heat exchangers. If this same picture holds true for all U.S. refineries, a potential would exist for saving up to 350,000 barrels of crude per day in the U.S. However, due to the technical and economic considerations that must be applied to each heater and exchanger, the actual savings would be limited to some fraction of this potential. E.D.K.

N80-28882# Department of Energy, Washington, D. C. Office of Technology Impacts.

### ENVIRONMENTAL DATA ENERGY TECHNOLOGY CHARACTERIZATIONS: COAL

Apr. 1980 172 p refs Supersedes DOE/EV-0061/3 (DOE/EV-0074; DOE/EV-0061/3) Avail: NTIS HC A08/MF A01

The activities leading to the conversion of coal to electricity consist of coal mining and beneficiation, coal transport, electric power generation, and power transmission. To enhance the usefulness of the material presented, resource requirements, energy products, and residuals for each activity area are normalized in terms of 10 to the 12th power Btus of energy produced. Thus, the total effect of producing electricity from coal can be determined by combining the residuals associated with the appropriate activity areas. Emissions from the coal cycle are highly dependent upon the type of coal consumed as well as the control technology assigned to the activity area. Each area is assumed to be equipped with currently available control technologies that meet environmental regulations.

N80-28885# Argonne National Lab., III. Energy and Environmental Systems Div.

HEAT-PUMP-CENTERED INTEGRATED COMMUNITY ENERGY SYSTEMS: SYSTEM DEVELOPMENT SUMMARY J. M. Calm Feb. 1980 127 p refs (Contract W-31-109-eng-38)

(ANL/CNSV-7) Avail: NTIS HC A07/MF A01

An introduction to district heating systems employing heat pumps to enable use of low temperature energy sources is presented. These systems operate as thermal utilities to provide space heating and may also supply space cooling, service water heating, and other thermal services. Otherwise wasted heat from industrial and commercial processes, natural sources including solar and geothermal heat, and heat stored on an annual cycle from summer cooling may be effectively utilized by the systems described. More than one quarter of the energy consumed in the United States is used to heat and cool buildings and to heat service water. Natural gas and oil provide approximately 83% of this energy. The systems described show potential to reduce net energy consumption for these services by 20 to 50% and to allow fuel substitution with less scarce resources not practical in smaller, individual building systems. Seven studies performed for the system development phase are DOE

N80-28888# Aluminum Co. of America, New Kensington, Pa.

DESIGN AND FABRICATION OF A LOW COST DARRIEUS VERTICAL AXIS WIND TURBINE SYSTEM, PHASE 1

22 Jun. 1979 345 p refs (Contract EM-78-C-04-4272)

(ALO-4272-T2) Avail: NTIS HC A15/MF A01

The Sandia 17 m was used as the background machine from which design information was drawn. By concentrating the modifications on an existing design, emphasis was focused on component cost reduction rather than selection of optimal configuration or operating modes. The resulting design is a stretched version of the Sandia 17 m preserving the same rotor diameter and many other good features, but lighter in weight, larger in capacity, and anticipated to be more cost effective.

DOE

N80-28916# Variflex Corp., Washington, D.C.
WORLDWIDE TRANSPORTATION/ENERGY DEMAND,
1975-2000: REVISED VARIFLEX MODEL PROJECTIONS
Robert U. Ayres and L. W. Ayres Mar. 1980 176 p refs
(Contract W-7405-eng-26)
(ORNL/Sub-79/45740/1) Avail: NTIS HC A09/MF A01

The salient features of the transportation energy relationships that characterize the world of 1975 are reviewed, and worldwide (34 countries) long-range transportation demand by mode to the year 2000 is reviewed. A worldwide model is used to estimate future energy demand for transportation. Projections made by the forecasting model indicate that in the year 2000, every region will be more dependent on petroleum

for the transportation sector than it was in 1975. Trends are

highlighted and areas for further investigation are suggested.

Forecast methodology and model output are described in detail.

DOE

N80-28918# Electric Power Research Inst., Palo Alto, Calif.
ENERGY ECONOMIC PROJECTIONS FOR THE
1979 OVERVIEW

Louise D. Cleary Sep. 1979 130 p refs (EPRI-PS-79-5-LD) Avail: NTIS HC A07/MF A01

Each year the EPRI Planning Staff publishes an overview to the 5 year research and development program plan. This report elaborates on and documents key energy demand and supply, economic, and financial issues analyzed in the Overview and Strategy 1980-1984 Research and Development Program Plan, EPRI-1141-PS. The report begins with a summary and expansion of energy and economic issues presented in the planning factors section of the Overview keyed to ETA-MACRO and WEM results. It is followed by an alternative view on the benefits of R and D planning. Next, key assumptions used in the models are outlined. Finally, sensitivity cases explore the implications of a moratorium on the construction of new nuclear plants in the US. Copies of the ETA-MACRO computer input and output from the Overview scenarios are available.

N80-28934# New England River Basins Commission, Boston, Mass.

POTENTIAL FOR HYDROPOWER DEVELOPMENT AT EXISTING DAMS IN NEW ENGLAND. VOLUME 1: PHYSICAL AND ECONOMIC FINDINGS AND METHODOLOGY Final Report

Jan. 1980 181 p

(PB80-169121; HP-1-80/1) Avail: NTIS HC A09/MF A01 CSCL 10B

The potential for hydropower development at existing dams in New England was investigated. The extent to which New England's dependence on foreign oil could be reduced through expansion of hydropower at existing dams is quantified in terms of energy and costs. A synopsis of the study methodology is presented.

N80-28935# New England River Basins Commission, Boston,

POTENTIAL FOR HYDROPOWER DEVELOPMENT AT EXISTING DAMS IN NEW ENGLAND. VOLUME 2: USER'S MANUAL Final Report

Jan. 1980 141 p

(PB80-169139; HD-1-80/2) Avail: NTIS HC A07/MF A01 CSCL 10B

The computer program HYELEC and its subroutines HYDPOT and ECOPOT is presented. HYELEC stores information relating to the hydropower potential of dams and can perform screening and ranking operations on these dams according to selected criteria pertaining to engineering practicability and economic feasibility. The computer language, the use of program control variables, and the sequence of events required for program operation are described.

N80-28958# North Dakota State Dept. of Health, Bismarck. Div. of Environmental Research.

THE LONG-TERM EFFECTS OF TRACE ELEMENTS EMITTED BY ENERGY CONVERSION OF LIGNITE COAL Final Report

Martin R. Schock, William W. Morrison, and Gene A. Christianson Jul. 1979 274 p. refs

(Contract OWRC-10773210)

(PB80-168867) Avail: NTIS HC A12/MF A01 CSCL 13B Results from a two year project, concerning effects of selected elements upon the ecosystem surrounding a 675 megawatt coal fired electrical generating facility are reviewed. The project involved the collection of coal, stack fly ash, aerosol, surface water, snow, sediments, soil, and vegetation samples for analysis of element concentrations. A modified atmospheric transport and deposition computer model was developed and used to predict ground level air concentrations and development of elements from the burning of lignite coal. The results of the project provide evidence of

enrichment of certain elements in aerosols, snow, water, soil surface, and vegetation.

N80-28960# North Dakota State Dept. of Health, Bismarck. Div. of Environmental Research.

THE LONG-TERM EFFECTS OF TRACE ELEMENTS EMITTED ENERGY CONVERSION OF LIGNITE COAL VOLUME 2: TECHNICAL APPENDICES Final Report

William W. Morrison, Martin R. Schock, and Gene A. Christianson Jul. 1979 211 p

(Contract OWRC-10773210)

(PB80-168875) Avail: NTIS HC A10/MF A01 CSCL 07D A two year project concerning effects of selected elements upon the ecosystem surrounding a 675 megawatt coal fired electrical generating facility, was completed. This involved the collection of coal, stack fly ash, aerosol, surface water, snow, sediments, soil, and vegetation samples for analysis of element concentrations. A modified atmospheric transport and deposition computer model was developed and used to predict ground level air concentrations and development of elements from the burning of lignite coal. The results provide evidence of enrichment of certain elements in aerosols, snow, water, soil surface, and vegetation.

N80-29156# National Academy of Engineering, Washington.

THE OUTLOOK FOR NUCLEAR POWER Final Report

David L. Bazelon, Harvey Brooks, Earnest F. Gloyna, Wolf Hafele. and Willis M. Hawkins Nov. 1979 81 p refs Presented at the Tech. Sess. of the Ann. Meeting of the Natl. Acad. Eng., Washington, D.C., 1 Nov. 1979 (PB80-175755; NAE-AMTS-1979; LC-80-80730;

ISBN-0-309-03039-0) Avail: NTIS HC A05/MF A01 CSCL 18I

Papers by authors from backgrounds in law, the aerospace industry, energy modeling, and engineering, focusing on several aspects of nuclear power attempt to present a balanced assessment of nuclear power and its role in the nation's energy future. Topics covered are: need for nuclear power worldwide including risks and benefits; technological improvements in the operation, safety, and reliability of nuclear power facilities: comparison to space program experience and commercial aircraft experience; problem of nuclear waste management; and projections of future world energy supply and demand and the role of nuclear power.

N80-29210# Societe Nationale Industrielle Aerospatiale, Paris (France). Div. Systemes Balistiques et Spatiaux. AEROSPACE TECHNOLOGY TRANSFER [RETOMBEES DE

TECHNOLOGIE SPATIALES Didier Compard 3 Sep. 1979 36 p In FRENCH Presented at AFAS Ann. Congr. 'La Conquete de l'Espace', Tregastel, France,

Sep. 1979 (SNIAS-792-422-112) Avail: NTIS HC A03/MF A01

The French policy for technology transfer from the aerospace industry is outlined. Some significant and promising candidates include: energy storage, electricial and magnetic components, medical equipment, and composite materials (carbon-carbon). Author (ESA)

N80-29516# Mitre Corp., McLean, Va. ENVIRONMENTAL DATA ENERGY TECHNOLOGY CHARAC-TERISTICS: SYNTHETIC FUELS

Apr. 1980 102 p refs (Contract EX-76-C-10-3876)

(DOE/EV-0073) Avail: NTIS HC A06/MF A01

The transformation of the energy in coal and oil shale into a more useful form is described in terms of major activity areas in the synthetic fuel cycles, that is, in terms of activities which produce either an energy product or a fuel leading to the production of an energy product in a different form. The activities discussed are coal liquefaction, coal gasification, in-situ gasification, and oil shales. These activities represent both well-documented and advanced activity areas. The former activities are characterized in terms of actual operating data with allowance for future modification where appropriate. Emissions are assumed to conform to environmental standards. The advanced activity areas examined are those like coal liquefaction and in-situ retorting of oil shale. For these areas, data from pilot or demonstration plants were used where available; otherwise, engineering studies provided the data.

N80-29833 Centec Corp., Fort Lauderdale, Fla. THE COATING INDUSTRY: ENERGY SAVINGS WITH VOLATILE ORGANIC COMPOUND EMISSION CONTROL Washington, D.C. DOE 1979 111 p refs (TID-28706) Copyright. Avail: Issuing Activity

Technical and economic data are presented to enable engineers and managers in the coating industry to evaluate the energy-conservation opportunities for installation of solvent emission-control systems. Although the properties of the solvents vary considerably, the information will serve to improve the ability of the engineer to make quick estimations of energy savings, energy rates, economics, and performance of control systems and heat-recovery options. Emphasis is directed to a discussion of add-on devices, such as thermal and catalytic incineration. Extensive graphics and illustrations show energy use, and economics; these are supplemented by calculations to be used by each plant to determine site-specific data.

N80-29837 Stanford Univ., Calif. MARKET PENETRATION OF ENERGY SUPPLY TECHNOL-OGIES Ph.D. Thesis

Robert James Condap 1980 131 p

Avail: Univ. Microfilms Order No. 8016814

Techniques to incorporate the concepts of profit-induced growth and risk aversion into policy-oriented optimization models of the domestic energy sector are examined. After reviewing the pertinent market penetration literature, simple mathematical programs in which the introduction of new energy technologies is constrained primarily by the reinvestment of profits are formulated. The main results involve the convergence behavior of technology production levels under various assumptions about the form of the energy demand function. Next, profitability growth constraints are embedded in a full-scale model of U.S. energyeconomy interactions. A rapidly convergent algorithm is developed to utilize optimal shadow prices in the computation of profitability for individual technologies. Allowance is made for additional policy variables such as government funding and taxation. The result is an optimal deployment schedule for current and future energy technologies which is consistent with the sector's ability to finance capacity expansion. Dissert. Abstr.

N80-29838# Booz-Allen and Hamilton, Inc., Bethesda, Md. ALTERNATIVE METERING PRACTICES. IMPLICATIONS FOR CONSERVATION IN MULTIFAMILY RESIDENCES

Jun. 1979 222 p

(Contract EC-77-C-03-1693)

(HCP/M1693-03) Avail: NTIS HC A10/MF A01

Comparisons are made of utility bills in multifamily residences where master meters and individual meters are used. Empirical evidence indicates that tenants who are made financially responsible for the energy they use, as in cases with individual or submetering, will consume less energy than tenants in a master situation. For electricity, the average savings are 15 to 20 percent. For gas, the savings are significantly less. The long-term impact of prohiting master meters is analyzed with regard to energy conservation, cost, and development of alternative energy sources for multifamily dwellings.

N80-29839# Department of Energy, Washington, D. C. Energy Information Administration.

CHARACTERISTICS OF THE HOUSING STOCK AND HOUSEHOLDS: PRELIMINARY FINDINGS FROM THE NATIONAL INTERIM ENERGY CONSUMPTION SURVEY 1 Oct. 1979 52 p

Avail: NTIS HC A04/MF A01

Results from a national interim energy consumption survey

#### 01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

designed to provide information related to energy consumption by the residential sector are presented. Information on energy use was collected at the household level. A representative (national) sample of households was selected in the 48 contiguous states plus the District of Columbia. The data on actual energy consumption was obtained from fuel records maintained by the household's fuel suppliers. Four sets of tables described the households and housing units including the general structural features of the units; household inventories of major appliances; heating equipment and the distribution of fuels used for space heating, water heating, and cooling; and socioeconomic characteristics.

N80-29840# Alaska State Div. of Energy and Power Development, Anchorage.

MINIMIZING CONSUMPTION OF EXHAUSTIBLE ENERGY RESOURCES THROUGH COMMUNITY PLANNING AND DESIGN. DEVELOPMENT OF PROCEDURES FOR APPLICATION DURING PUBLIC FACILITIES PROCUREMENT PROCESS. PHASE 2: EXTENSION Final Report

Feb. 1979 151 p

(Contract EX-76-C-06-2332)

HC A03/MF A01 CSCL 10B

(RLO-2332-3) Avail: NTIS HC A08/MF A01

The State of Alaska's Division of Energy and Power Development conducted a study of energy conservation measures that can be incorporated in public facilities and a new community such as that proposed for the State capital, should it be relocated. The process by which such facilities are procured was revised to incorporate analysis of energy conservation measures and the control of their incorporation. Supporting procedures were also developed.

N80-29861\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

INTERGENERATIONAL EQUITY AND CONSERVATION
Richard P. Otoole and A. L. Walton 15 Jun. 1980 28 p refs
(NASA-CR-163434; JPL-Pub-80-49) Avail: NTIS

The issue of integenerational equity in the use of natural resources is discussed in the context of coal mining conversion. An attempt to determine if there is a clear-cut benefit to future generations in setting minimum coal extraction efficiency standards in mining is made. It is demonstrated that preserving fossil fuels beyond the economically efficient level is not necessarily beneficial to future generations even in terms of their own preferences. Setting fossil fuel conservation targets for intermediate products (i.e. energy) may increase the quantities of fossil fuels available to future generations and hence lower the costs, but there may be serious disadvantages to future generations as well. The use of relatively inexpensive fossil fuels in this generation may result in more infrastructure development and more knowledge production available to future generations. The value of fossil fuels versus these other endowments in the future depends on many factors which cannot possibly be evaluated at present. Since there is no idea of whether future generations are being helped or harmed, it is recommended that integenerational equity not be used as a factor in setting coal mine extraction efficiency standards, or in establishing requirements. R.K.G.

N80-29868# Oak Ridge National Lab., Tenn. Environmental Sciences Div.

ENVIRONMENTAL CONSTRAINTS ON GEOTHERMAL ENERGY

R. B. Craig 1979 8 p refs Presented at the Intern Conf. on Energy Use Management, Los Angeles, 22 Oct. 1979 (Contract W-7405-eng-26)

(ORNL-1310: CONF-791009) Avail: NTIS HC A02/MF A01
The environmental impacts of DOE's major geothermal programs and more than 15 projects at specific sites have been assessed. Site characteristics conducive to potentially severe environmental impacts and which tend to recur at site after site were identified. These characteristics are discussed.

N80-29886\*# Argonne National Lab., III. Integrated Assessments and Policy Evaluations Group.

PRELIMINARY COMPARATIVE ASSESSMENT OF LAND USE FOR THE SATELLITE POWER SYSTEM (SPS) AND ALTERNATIVE ELECTRIC ENERGY TECHNOLOGIES

D. E. Newsom and T. D. Wolsko Apr. 1980 26 p refs Sponsored by NASA

(Contract W-31-109-eng-38)

(NASA-CR-163327: DOE/ER-0054) HC A03/MF A01 CSCL 10A

Avail: N115

DOE

A preliminary comparative assessment of land use for the satellite power system (SPS), other solar technologies, and alternative electric energy technologies was conducted. The alternative technologies are coal gasification/combined-cycle, coal fluidized-bed combustion (FBC), light water reactor (LWR), liquid metal fast breeder reactor (LMFBR), terrestrial photovoltaics (TPV), solar thermal electric (STE), and ocean thermal energy conversion (OTEC). The major issues of a land use assessment are the quantity, purpose, duration, location, and costs of the required land use. The phased methodology described treats the first four issues, but not the costs. Several past efforts are comparative or single technology assessment are reviewed briefly. The current state of knowledge about land use is described for each technology. Conclusions are drawn regarding deficiencies in the data on

N80-29887\*# Argonne National Lab., III. Integrated Assessment and Policy Evaluation Group.

comparative land use and needs for further research.

SELECTION OF ALTERNATIVE CENTRAL-STATION TECH-NOLOGIES FOR THE SATELLITE POWER SYSTEM (SPS) COMPARATIVE ASSESSMENT

Michael E. Samsa Apr. 1980 19 p Sponsored by NASA (Contract W-31-109-eng-38)

(NASA-CR-163328: DOE/ER-0052) Avail: NTIS HC A02/MF A01 CSCL 10A

An important effort is the Satellite Power System (SPS) comparative Assessment is the selection and characterization of alternative technologies to be compared with the SPS concept. The ground rules, criteria, and screening procedure applied in the selection of those alternative technologies are summarized. The final set of central station alternatives selected for comparison with the SPS concept includes: (1) light water reactor with improved fuel utilization, (2) conventional coal combustion with improved environmental controls, (3) open cycle gas turbine with integral low Btu gasifier, (4) terrestrial photovoltaic, (5) liquid metal fast breeder reactor, and (6) magnetic confinement fusion.

N80-29912# Department of Energy, Washington, D. C. Office of Technology Impacts.

ENVIRONMENTAL DATA, ENERGY TECHNOLOGY CHARACTERIZATIONS: GEOTHERMAL
Apr. 1980 41 p refs

(DOE/EV-0077) Avail: NTIS HC A03/MF A01

Two hydrothermal convective systems are discussed: vapor dominated and liquid dominated. The following topics are covered for each: characteristics, constraints, resource consumption, environmental considerations, and economic data.

N80-29926# Kansas Water Resources Research Inst., Manhattan, SOLUBILITY OF SELECTED MAJOR AND MINOR ELEMENTS FROM COAL AND FLY ASH ACCUMULATIONS Completion Report, Jul. 1977 - Sep. 1979

D. A. Kposick and Ernest E. Angino Mar. 1980 29 p (PB80-175334; W80-04604; OWRT-A-087-KAN-1) Avail: NTIS HC A03/MF A01 CSCL 13B

Different fly and bottom ashes, representing four coal producing areas of the United States were used in leaching experiments for Ca. Mg. Na, K. Fe, Mn, Zn, Cu, Pb, and Cd and the potential for contamination of ground and surface water supplied by these elements. Both fly ash and bottom ash are formed by the thermal decomposition or dehydration of inorganic impurities in coal and vary with the type of coal used. Many factors affect leachate characteristics such as coal preparation methods, method and efficiency of combustion, method of disposal, particle morphology, and others.

N80-29928# Automation Industries, Inc., Silver Spring, Md. Vitro Labs Div.

ENERGY/ENVIRONMENT 4: PROCEEDINGS OF THE NATIONAL CONFERENCE ON THE INTERAGENCY ENERGY/ENVIRONMENT R AND D PROGRAM Decision Series Francine S. Jacoff, Elinor Voris, and Gary M. Sitek Oct. 1979 311 p refs Conf. held in Washington, D.C., 7-8 Jun. 1979 (Contract EPA-68-01-2934)

(PB80-177942: EPA-600/9-79-040) Avail: NTIS HC A14/MF A01 CSCL 13B

An update of interagency research programs in particular areas, including health effects, transport processes and ecological effects, mining methods and reclamation, control technology and integrated technology assessment is given.

N80-30224# Committee on Science and Technology (U. S. House)

#### DOE AUTHORIZATION, 1981, VOLUME 2

Washington GPO 1980 720 p Hearings before the Subcomm. on Energy Res. and Production of the Comm. on Sci and Technol. 96th Congr., 2nd Sess., no. 114, 5, 7, 12, 13 Feb. and 4 Mar. 1980

(GPO-61-774-Vol-2) Avail: Subcommittee on Energy Research and Production

Testimony given on the Department of Energy's budget request for fiscal year 1981 is presented. An overview of the Nation's nuclear energy programs is given. Emphasis is placed on energy production from nuclear power to meet electrical energy needs for the remainder of the century. Nuclear plant safety and reliability, nuclear waste disposal and management, light water reactor technology, advanced fission technology, breeder reactor technology, spent fuel storage and reprocessing, and advanced isotope separation technology are among the topics discussed.

N80-30225# Committee on Science and Technology (U. S. House).

#### NASA AUTHORIZATION, 1981, VOLUME 5

Washington GPO 1980 1164 p Hearings on H.R. 6413 before the Subcomm. on Space Sci. and Appl. of the Comm. on Sci. and Technol., 96th Congr., 2nd Sess., no. 18, 20, 21, 26 Feb., 7-10, 31 Mar. 1980

(GPO-61-213-Vol-5) Avail: Subcommittee on Space Science and Applications

Testimony given on the cooperative energy programs being conducted by NASA for the Department of Energy is presented in light of the budget request for fiscal year 1981. Solar energy activities including small dispersed solar system applications and bioenergy as well as ocean thermal energy conversion, solar augmented desalination systems, and solar ranking applications are discussed. Coal preparation and conversion technologies are also considered. These technology options include coal gasification and liquefaction processes, coal gasifier congeneration systems, and coal fired energy conversion systems. Concepts that would extend the use of advanced systems based in space are examined. including the satellite power systems, orbiting reflectors, and lunar based power plants. The NASA support to the DOE in the solar programs areas of solar heating and cooling, wind energy, solar cells-photovoltaic conversion systems, and high temperature thermal conversion systems is highlighted.

## N80-30226# Committee of Conference (U. S. Congress). NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AUTHORIZATION ACT, 1981

Washington, D.C. GPO 1980 5 p

(Pub-Law-96-316; GPO-59-139) Avail: US Capitol, Senate Document Room

The congressional act authorizing appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management is presented. A breakdown of allocations to specific projects is provided, and expenditure provisions are outlined.

M.G

N80-30234# Massachusetts Inst. of Tech., Cambridge. Energy Lab

## ASSESSMENT OF INTEGRATED URBAN ENERGY OPTIONS

Gerald D. Pine Feb. 1979 236 p refs (PB80-173644; MIT-EL-79-021) HC A11/MF A01 CSCL 13A

Avail: NTIS

An initial comparison is carried out for the following residential space and water heating options: electric resistance heating, electrically driven heat pumps, distribution of condenser temperature water combined with heat pumps to extract heat at the point of use, district heating via hot water from a combined heat-electric utility energy source, and individual gas furnaces. This comparison indicates that district is potentially competitive with conventional technologies for new urban areas. Base case urban models, economic assumptions, and distribution networks are defined and a computer program is developed to select optimum pipe sizes for the networks and to calculate life cycle costs.

# NBO-30903# Pacific Missile Test Center, Point Mugu, Calif. PACIFIC MISSILE TEST CENTER ENERGY PROJECTS. SUMMARY OF PROJECTS, CONTRIBUTIONS, AND PLANS

 Jay Rosenthal and Craig Savant Jan. 1980 53 p refs

 (AD-A086196; PMTC-TP-80-14)
 Avail: NTIS

 HC A04/MF A01 CSCL 13/2

This report is a compilation of the projects undertaken at the Pacific Missile Test Center to conserve energy, develop and apply alternative energy sources, and develop, in the 1980s, basic capability (BACADE) projects for applying energy-saving technology to the needs of the Pacific Missile Test Center. GRA

N80-30914# Argonne National Lab., III. Integrated Assessments and Policy Evaluations Group.

## CLIMATE AND ENERGY: A COMPARATIVE ASSESSMENT OF THE SATELLITE POWER SYSTEM (SPS) AND ALTERNATIVE ENERGY TECHNOLOGIES

David A. Kellermeyer Jan. 1980 69 p refs (Contract W-31-109-eng-38) (DDE/ER-0050) Avail: NTIS HC AO4/MF AO1

The potential effects of five energy technologies on global, regional, and local climate are assessed. The energy technologies examined are coal combustion, light water nuclear reactors, satellite power systems, terrestrial photovoltaics, and fusion. The assessment focuses on waste heat rejection, production of particulate aerosols, and emission of carbon dioxide. The current state of climate modeling and long range climate prediction introduces considerable uncertainty into the assessment, but it may be concluded that waste heat will not produce detectable changes in global climate until world energy use increases 100 fold, although minor effects on local weather may occur now; that carbon dioxide from coal combustion in the US alone accounts for about 30% of the current increase in global atmospheric CO2 which may, by about 2050 increase world temperature 2 to 3 C, with pronounced effects on world climate; and that rocket exhaust from numerous launches during construction of a satellite power system may affect the upper atmosphere, with uncertain consequences.

N80-30915# Argonne National Lab., III. Integrated Assessments and Policy Evaluations Group.

COMPARATIVE ASSESSMENT OF ENVIRONMENTAL WELFARE ISSUES ASSOCIATED WITH THE SATELLITE POWER SYSTEM (SPS) AND ALTERNATIVE TECHNOLOGIES

E. P. Levine, M. J. Senew, and R. R. Cirillo Apr. 1980 99 p refs

(Contract W-31-109-eng-38)

(DOE/ER-0055) Avail: NTIS HC A05/MF A01

Environmental deterioration and associated welfare effects from two mature electric power generation systems (combustion of coal and light water nuclear reactors) are compared with those expected from a conceptual satellite power system. Each activity within the energy pathway for each power system is examined to determine the potential welfare effects it imposes

on a community. The severities of these effects are compared. On the basis of this comparison and the state of knowledge concerning specific environmental impacts and welfare effects, key environmental issues are identified for subsequent, in-depth analyses.

N80-30916# Argonne National Lab., III. Energy and Environmental Systems Div

#### COMPARATIVE ANALYSIS OF NET ENERGY BALANCE FOR SATELLITE POWER SYSTEMS (SPS) AND OTHER ENERGY SYSTEMS

R. R. Cirillo, B. S. Cho, M. R. Monarch, and E. P. Levine Apr. 1980 143 p refs

(Contract W-31-109-eng-38)

(DOE/ER-0056) Avail: NTIS HC A07/MF A01

The net energy balance of seven electric energy systems is assessed: two coal-based, one nuclear, two terrestrial solar, and two solar power satellites, with principal emphasis on the latter two systems. Solar energy systems require much less operating energy per unit of electrical output. However, on the basis of the analysis used here, coal and nuclear systems are two to five times more efficient at extracting useful energy from the primary resource base than are the solar energy systems. The payback period for all systems is less than 1.5 years, except for the terrestrial photovoltaic (19.8 yr) and the solar power satellite system (6.4 yr), both of which rely on energy-intensive silicon

N80-30923# Sandia Labs., Albuquerque, N. Mex. Photovoltaic Projects Div.

### PHOTOVOLTAIC SYSTEMS AND APPLICATIONS PERSPEC-

Gary J. Jones 1980 8 p refs Presented at the Am. Sect. of the Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2 Jun. 1980 (Contract EY-76-C-04-0789)

(SAND-80-0926C: CONF-800604-14) NTIS HC A02/MF A01

The National Photovoltaic Program is currently in the proccess of increasing emphasis on full scale system experiments in the potential user environment. At this point large amounts of design information are available and need to be brought together in usable form to support this effort. The state of understanding in the system definition area for the major applications is reviewed, and the remaining issues, especially as they impact the field test activities, are indicated.

#### N80-30936# Brookhaven National Lab., Upton, N. Y. COMPARATIVE ASSESSMENT OF FIVE LONG-RUN **ENERGY PROJECTIONS**

Andy S. Kydes and John D. Pearson Dec. 1979 134 p refs (Contract DE-AC02-76CH-00016)

(DOE/EIA/CR-0016/02). Avail: NTIS HC A07/MF A01

Five long term forecasts of energy projection are compared under similar assumptions. These include: (1) PILOT Process integrated Model/Welfare Equilibrium Model system (PILOT or PPIM/WEM); (2) ETA-MACRO energy economy model system; (3) the combined Brookhaven National Laboratory (DNL/DJA) energy model system: (4) the FOSSIL2 (1978) energy model; and (5) the Long range Energy Analysis Package energy model ARC-78. The method of preparation of each forecast is summarized and the differences are explained both in terms of data assumption and methodological approach.

N80-30938# Oak Ridge National Lab., Tenn. Energy Div. THERMALLY DRIVEN OPEN-CYCLE HEAT PUMP SYSTEM F. C. Chen 1980 9 p refs Presented at the 11th Ann. Modeling and Simulation Conf., Pittsburgh, 1 May 1980 (Contract W-7405-eng-26)

(CONF-800549-1) Avail: NTIS HC A02/MF A01

The technical feasibility of a thermally driven open cycle heat pump is analyzed through the design simulation. It is intended to utilize waste heat from Federal nuclear facilities via temperature augmentation for process steam production. Based on the simulation analysis, the design of the open cycle heat pump to supply 4535 kg/hour 10,000 lb/hour, 121 C process steam is within the state-of-the-art. Its energy savings and cost estimate as compared to a baseline case and the alternatives are also presented.

N80-30942# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

ENERGY ANALYSIS PROGRAM, FY 1979

Apr. 1980 78 p refs

(Contract W-7405-eng-48) (LBL-10320) Avail: NTIS HC A05/MF A01

Energy analysis attempts to understand the volitional choices of energy use and supply available to human society, and the multi-faceted consequences of choosing any one of them. Topics deal with economic impacts; assessments of regional issues and impacts; air quality evaluation; institutional and political issues in California power plant siting; assessment of environmental standards; water issues; characterization of aquatic systems dissolved oxygen profiles; modeling; computer-generated interactive graphics; energy assessment in Hawaii; solar energy in communities; utilities solar financial data; population impacts of geothermal development; energy conservation in colleges and residential sectors; energy policy; decision making; building energy performance standards; standards for residential appliances; and impact of energy performance standards on demand for peak electrical energy.

N80-30964# Environmental Protection Agency, Ann Arbor, Mich. Test and Evaluation Branch.

#### EVALUATION OF THE RAM-JET DEVICE, A PCV AIR BLEED

Edward Anthony Barth Jan. 1980 14 p (PB80-170657; EPA-AA-TAEB-80-10) NTIS HC A02/MF A01 CSCL 13F

The potential for emission reduction or fuel economy improvement compared to conventional engines and vehicles was determined for retrofit device designed to bleed in extra air to the engine by allowing ambient air to bypass the carburetor under high engine load conditions.

N80-30966# North Carolina Univ. at Chapel Hill. School of Public Health.

PHOTOCHEMICAL STUDY OF NOX REMOVAL FROM STACK GASES Final Report, Jan. 1977 - Mar. 1979 John R. Richards and Donald L. Fox Mar. 1980 202 p refs

(Grant EPA-R-804740) NTIS

(PB80-181274; EPA-600/7-80-038) . Avail: HC A10/MF A01 CSCL 07E

The technical feasibility of a photochemical pretreatment system for NOx control at coal fired boilers is evaluated. The approach utilizes reaction mechanisms similar to those responsible for photochemical oxidant incidents. The reactions are initiated under controlled conditions while the pollutants are at high concentration and while the reaction products can be removed. Results indicate that, under time and light limited conditions, it is possible to quench the photochemical reactions at the NC2 peak and prior to the formation of ozone, aerosols, and other secondary products. Photochemical oxidation of NO was insensitive to SO2 concentration and CO2 concentration. The photochemical system appears compatible with conditions resulting from combustion modifications to suppress NOx generation. GRA

N80-31026# Science Applications, Inc., Raleigh, N.C. SOUTH ATLANTIC OCS PHYSICAL OCEANOGRAPHY, VOLUME 2 Final Report Mar. 1980 348 p refs

NTIS

(Contract DI-AA550-CT7-29)

(PB80-181555; BLM/YM/ES-80/2)

HC A15/MF A01 CSCL 08C

The results of the first year of a four year physical oceanographic and meteorological data collection effort on the Outer Continental Shelf (OCS) from Cape Hatteras, North Carolina to Cape Canaveral, Florida, during the period of September 1977 through November 1978 are presented. Currents, circulation

and mixing processes in the Georgia Embayment/South Atlantic Bight (SAB) are studied to assess the effects of CCS oil and gas activities on the biological environment, as well as on recreational and commercial fishing. GRA

N80-31027# Science Applications, Inc., Raleigh, N.C. SOUTH ATLANTIC OCS PHYSICAL OCEANOGRAPHY. **VOLUME 3** Final Report

Mar. 1980 638 p Original contains color illustrations

(Contract DI-AA550-CT7-29) (PB80-181563: BLM/YM/ES-80/3-Vol-3)

Avail: NTIS HC A99/MF A01 CSCL 08J

The complete sets of Data Products resulting from the short-term and long-term current meter mooring data, hydrograph-, ic sampling, and meteorology/sea state observations are presented. Ship tracks and sampling plans followed on each cruise are included along with cross-shelf sections and spatial distribution of hydrographic variables.

N80-31272# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ELECTRIC AND HYBRID VEHICLE SYSTEM RESEARCH AND DEVELOPMENT PROJECT: HYBRID VEHICLE POTENTIAL ASSESSMENT. VOLUME 1: SUMMARY Frank T. Surber 30 Sep. 1979 70 p refs 10 Vol.

(Contract EM-78-I-01-4209)

(CONS-4209-T1-Vol-1) Avail: NTIS HC A04/MF A01

The potential of hybrid vehicles as a replacement of the conventional gasoline or diesel fueled internal combustion engine vehicle within the next 20 to 30 yr are considered. Hybrid vehicle designs and applications which are technically and economically viable are discussed. Critical technical areas where research and development can be most usefully concentrated

N80-31274# Jet Propulsion Lab., California Inst. of Tech.,

ELECTRIC AND HYBRID VEHICLE SYSTEM RESEARCH AND DEVELOPMENT PROJECT, HYBRID VEHICLE POTEN-TIAL ASSESSMENT. VOLUME 6: COST ANALYSIS

K. S. Hardy 30 Sep. 1979 106 p (Contract EM-78-I-01-4209)

(CONS-4209-T1-Vol-6) Avail: NTIS HC A06/MF A01

The economic feasibility of a variety of hybrid vehicles with respect to conventional vehicles specifically designed for the same duty cycle defined by the mission analysis was determined. Several different hybrid configurations including parallel, parallel-flywheel, and series vehicles were evaluated. The ramifications of incorporating examples of advanced batteries, these being the advanced lead acid, nickel zinc, and sodium sulfur were also investigated. Vehicles were specifically designed with these batteries and for the driving cycles specified by the mission. It was concluded that: in the event that gasoline prices: reach \$2.50 to \$3.00/gal, hybrid vehicles in many applications will become economically competitive with conventional vehicles without subsidization; in some commercial applications hybrid vehicles could be economically competitive, when the gasoline price ranges from \$1.20 to \$1.50/gal.

N80-31275# Jet Propulsion Lab., California Inst. of Tech.,

ELECTRIC AND HYBRID VEHICLE SYSTEM RESEARCH AND DEVELOPMENT PROJECT, HYBRID VEHICLE POTEN-TIAL ASSESSMENT. VOLUME 8: SCENARIO GENERA-TION

K. O. Leschly 30 Sep. 1979 43 p refs (Contract EM-78-I-01-4209)

(CONS-4209-T1-Vol-8) Avail: NTIS HC A03/MF A01

Scenarios are described which have been generated to develop of consistent and credible forecasts required to estimate the potential impact of hybrid vehicles on future petroleum consumption in the USA, given a set of specific electric, hybrid and conventional vehicle designs. The four major areas of concern are population and vehicle fleet size, travel patterns and vehicle fleet mix. conventional vehicle technology (Otto baseline),

battery technology, and prices. The forecasts were generated to reflect two baseline scenarios, a Petroleum Conservation Scenario and an Energy Conservation Scenario. The primary assumption in scenario A is higher gasoline prices than in scenario B. This should result in less travel per car and an increased demand for smaller and more fuel efficient cars. In scenario B the primary assumption is higher prices on cars (new as well as used) than in scenario A. This should lead to less cars and a shift to other modes of transportation. DOE

N80-31402\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

IMPROVED COMPONENTS FOR ENGINE FUEL SAVINGS Robert J. Antl and John E. McAulay 1980 33 p. refs Presented at the Aerospace Congr., Los Angeles, 13-16 Oct. 1980: sponsored by Am. Soc. of Automotive Engr.

(NASA-TM-81577; E-506) Avail: NTIS HC A03/MF A01 CSCL

The Engine Component Improvement (ECI) Project formulated to address near term improvements for current engines is described with emphasis on the development of component technologies to reduce the fuel consumption of CF6, JT9D, and JT8D engines. The technical and economical acceptability and the fuel saving potential of nine concepts are demonstrated. Descriptions of these concepts, results of testing, and the status as to entering airline service are presented. Also presented is the status of the remaining concepts still under development.

N80-31472\*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AN IMPROVED SYNTHESIS OF 2,4,8,10-TETROXASPIRO (5.5) UNDECANE Patent Application

Algirdas C. Poshkus, inventor (to NASA) (National Academy of Sciences - National Research Council, Washington, D.C.) Filed 3 Sep. 1980 10 p Sponsored by NASA

(NASA-Case-ARC-11243-2; US-Patent-Appl-SN-183707) Avail: NTIS HC A02/MF A01 CSCL 07C

Pentaerythritol can be converted to its diformal, 2,4,8, 10 -tetroxaspiro (5.5) lundecane, by heating it of a temperature within of about 110 to 150 C for a period of up to 10 minutes. in the presence of a slight excess of paraformaldehyde and of a catalytic quantity of an acid catalyst such as sulfuric acid. The reaction may be carried out in two steps, by forming first the monoformal, then the diformal. In any case, total reaction time is about 10 minutes and yield of diformal are greater than 90 percent. Several advantages of the improved process in terms of shortened reaction times, yields labor and energy requirements, adaptability to continuous operation, and overall simplicity and convenience are discussed. NASA

N80-31632# Oak Ridge National Lab., Tenn. Analytical Chemistry Div.

FOSSIL FUELS RESEARCH MATRIX PROGRAM. ENVIRONMENTAL PROTECTION AGENCY/DEPARTMENT OF ENERGY FOSSIL FUELS RESEARCH MATERIALS **FACILITY** 

W. H. Griest and M. R. Guerin, Jun. 1980, 52 p. refs. (Contract W-7405-eng-26)

(ORNL/TM-7346) Avail: NTIS HC A04/MF A01

Health and environmental-effects studies of alternate fossil fuels technologies were conducted. Sets of sample differing in some systematic manner (e.g., coal-, shale-, and petroleum-derived counterparts; processing history; etc.) were brought to the attention of investigators expert in various biological and chemical tests systems. The result is a series of matrix experiments whereby various groups apply a variety of tests to given sets of samples. The matrix program provides a convenient source of useful samples and guidance on sample characteristics and data gaps in exchange for results of the individual investigations.

N80-31673# National Bureau, of Standards, Washington, D.C. Center for Building Technology. ENERGY BUDGET PROCEDURES AND PERFORMANCE

#### CRITERIA FOR ENERGY CONSERVING BUILDING ILLU-MINATION SYSTEMS

Albert T. Hattenburg, Jim L. Heldenbrand, D. K. Ross, R. G. Stein, and W. Taq May 1980 122 p refs (Contract EA-77-A-01-6010)

(PB80-184229: NBSIR-80-2052) Avail: NTIS

HC A06/MF A01 CSCL 13A

Subsystem energy budget development procedures and performance criteria for building illumination were developed by a consultant team of practitioners experienced in building illumination systems. A general procedure is described wherein the energy required for efficient illumination of a building is examined and corresponding power and annual energy budget guidelines are developed. This methodology is applied to three classes of building offices, schools, and residences to illustrate the method. Representative power and energy budgets are developed.

N80-31796\*# Eaton Corp., Southfield, Mich. Engineering and Research Center.

#### SMALL PASSENGER CAR TRANSMISSION TEST; CHEV-ROLET LUV TRANSMISSION Final Report

M. P. Bujold Jun. 1980 428 p

(Contract DEN3-124; EC-77-A-31-1044)

(NASA-CR-159882; ERC-LIB-80121; DOE/NASA/0124-3)

Avail: NTIS HC A19/MF A01 CSCL 131

A 1978 Chevrolet LUV manual transmission tested per the applicable portions of a passenger car automatic transmission test code (SAE J65lb) which required drive performance, coast performance, and no load test conditions. Under these test conditions, the transmission attained maximum efficiencies in the upper ninety percent range for both drive performance tests and coast performance tests. The major results of this test (torque, speed, and efficiency curves) are presented. Graphs map the complete performance characteristics for the Chevrolet LUV transmission.

A.R.H.

N80-31915# Illinois Univ. at Urbana-Champaign, Urbana. Office of Vice Chancellor for Research.

### ENERGY ANALYSIS OF GEOTHERMAL-ELECTRIC SYSTEMS

Robert A. Herendeen and Randall Plant Dec. 1979 215 p refs

(Contract ET-78-S-02-5085)

(COO-5085-4) Avail: NTIS HC A10/MF A01

Standard energy analysis was applied to 4 types of geothermal-electric technologies: liquid dominated, hot dry rock, geopressure, and vapor dominated. It was found that all are net energy producers. Expected uncertainties are not large enough to threaten this conclusion. Vapor dominated, the only technology in current commercial use to produce electricity in the US, has the highest energy ratio (13 ÷ · 4). These results for energy ratio are equal to or less than some from other workers. In the case of liquid dominated, environmental control technology has a considerable energy requirement.

N80-31939# Oak Ridge Associated Universities, Tenn. Inst. for Energy Analysis.

## ASSESSMENT OF INDUSTRIAL ENERGY CONSERVATION BY UNIT PROCESSES

Doan L. Phung, Willem vanGool, David A. Boyd, Dominique Casavant, Warren D. Devine, Jr., Heriberto Plasa, and William G. Pollard Mar. 1980 191 p

(Contract DE-AC05-760R-00033)

(ORAU/IEA-80-4-M) Avail: NTIS HC A09/MF A01

The investment required to produce a given amount of conservation, the amount of conservation to be accomplished before costs equal those of new supply, and how a given investment should be allocated to yield the largest energy savings are questions addressed from the perspective of energy use in industrial unit operations. It was found that: a real energy minimum exists which is distinct from the process thermodynamic limit and this minimum represents the limit to conservation; cost/energy relationships for an industrial process can be described to first approximation by a single technology parameter which is

characteristic of that particular technology; the technology parameter permits competing technologies to be ranked by energy saving potential for a given investment; and government investment in conservation can be allocated for greatest return using the technology parameters of, and the fractions of energy use by, each of the unit operations. Energy embodied in conservation equipment may, under certain circumstances, decrease the rate at which the benefits of conservation appear in national energy accounts.

N80-31940# Battelle Columbus Labs., Ohio.

PILOT STUDY TO SELECT CANDIDATES FOR ENERGY. CONSERVATION RESEARCH FOR THE CHEMICAL INDUSTRY Final Report

J. E. Burch, J. L. Otis, and R. W. Hale 15 Nov. 1979 116 p

(Contract W-7405-eng-92)

(DOE/TIC-11114) Avail: NTIS HC A06/MF A01

The functions and energy consumption of the various unit operations involved in several chemical processes are studied and areas where research could lead to energy-conservation options of broad utility to the chemical industry are identified. Four energy-intensive chemical processes which produce ammonia and carbon dioxide, chlorine and caustic soda, carbon black, and ethylbenzene and styrene were selected. Information was obtained from the literature on the structure of the industry sectors and the production technologies, and was used to determine material balances, process streams, temperatures, pressures, and energy requirements for the various unit operations. An energy matrix was prepared for each process, showing the function provided by and the energy involved in each unit operation or process. A variety of chemical engineers and chemists analyzed the energy matrices, flow charts, and other information for each process and made suggestions as to areas wherein research might be expected to produce energy saving results. DOE

### N80-31950# Battelle Columbus Labs., Ohio. PHOTOVOLTAIC INSTITUTIONAL ISSUES STUDY

George A. Watkins, Gerry Noel, John Hagely, John Broehl, Mary Duchi, Harry Smail, Tom Martineau, and Ben Maiden Apr. 1980 223 p. refs

(Contracts DE-AC04-76DP-00789; W-7405-eng-92) (SAND-79-7054) Avail: NTIS HC A10/MF A01

Institutional issues are presented in the context of nine prototypical systems, designed to reflect institutional issue variation. Key institutional issues associated with each of the aforementioned issue areas were explored to demonstrate their relevance to application of photovoltaics. Programmatic recommendations are made which could serve to address institutional issues identified. Opportunities for those persons, agencies and governmental entities involved in the commercialization and widespread use of photovoltaics to address the institutional issues identified are included.

N80-31968# Dartmouth Coll., Hanover, N.H. Resource Policy Center

#### INTERACTIONS BETWEEN ENERGY SUPPLY AND TRANS-PORTATION-RELATED ENERGY USE, VOLUME 1 Final Report

Thomas J. Adler, John W. Ison, and Jay C. Geinzer Jan. 1980 177 p refs

(Contract DOT-RC-82003)

(PB80-185002; DOT/RSPA/DPB-50-80-7) Avail: NTIS HC A09/MF A01 CSCL 10A

The structure of ENTRANS and some of its policy analysis applications are described. ENTRANS is a computer simulator model of the interactions between energy supply and transportation related energy use. It includes a complete representation of the characteristics of transportation supply (public transit, carpooling, highways, and autos) and of households' travel related decisions (car type, travel mode, trip length, and frequency choices). The model is capable of analyzing a wide range of policies designed to change automobile fuel use. The results of several detailed policy analyses are described.

N80-31982# KVB Inc., Irvine, Calif. Research and Analyses Div.

DETERMINATION OF AIR POLLUTANT EMISSION FAC-TORS FOR THERMAL TERTIARY OIL RECOVERY OPERA-TIONS IN CALIFORNIA, VOLUME 1 Final Report

Harold J. Taback. May 1980 92 p refs (Contract ARB:A7-075-30)

(PB80-187594; KVB-5807-842-Vol-1; ARB-R-80/116) Avail: NTIS HC A05/MF A01 CSCL 13B

Results of a study to determine the nature and extent of air pollutants resulting from thermally enhanced oil recovery operations in California are presented. Emission factors for some of the sources of these pollutants were determined. The pollutants of concern were particulate matter, sulfur oxides, nitrogen oxides, carbon monoxide, hydrocarbons, and hydrogen sulfide. Emission factors were developed by source testing steam generators and two types of well vents, those associated with steam injection fields and those associated with in-situ combustion (or fireflood) oil recovery methods.

N80-31983# KVB Inc., Irvine, Calif. Research and Analyses Div

DETERMINATION OF AIR POLLUTANT EMISSION FAC-TORS FOR THERMAL TERTIARY OIL RECOVERY OPERA-TIONS IN CALIFORNIA. VOLUME 2: APPENDIX Final Report

Harold J. Taback Nov. 1979 190 p

(Contract ARB-A7-075-30)

(PB80, 187602; KVB-5807-842-Vol-2; ARB-R-79/117) Avail: NTIS HC A09/MF A01 CSCL 13B

Detailed data from tests conducted during the program is given. GRA

N80-31984# Army Cold Regions Research and Engineering Lab., Fort Wainright, Alaska. Alaskan Projects Office.
THE FATE AND EFFECTS OF CRUDE OIL SPILLED ON SUBARCTIC PERMAFROST TERRAIN IN INTERIOR ALASKA Final Report, 1975 - 1979

L. A. Johnson, E. B. Sparrow, T. F. Jenkins, C. M. Collins, C. V. Davenport, and T. T. McFadden Mar. 1980 143 p refs (Grant EPA-IAF-D7-0794)

(PB80-187305; EPA-600/

HC A07/MF A01 CSCL 08L

EPA-600/3-80-040) Avail: NTIS CSCL 08L

The short and long term effects of spills of hot Prudhoe Bay crude oil on permafrost terrain in subarctic interior Alaska were studied after two experimental oil spills of 7570 liters (2000 gallons) each one in winter and one in summer, on 500 sqm test plots were made at a forest site underlain by permafrost. Oil movement, thermal regime, botanical effects, microbiological responses, permafrost impact, and composition of the oil in the soil were monitored for two years. Oil movement during the winter spill occurred within the surface moss layer beneath the snow. In the summer spill, movement of the oil was primarily below the moss in the organic soil and was more rapid, moving 30 m downslope in the first 24 hours and 41 m total through the summer. The oil in the winter spill moved only 18 m downslope in the first day and stopped. Remobilization occurred in the spring allowing the oil in the winter spill to move an additional 17 m. The total area affected by the summer spill was nearly one and one-half times as large as the winter spill.

## N80-32203# Union Carbide Corp., Oak Ridge, Tenn. ASSUMPTIONS AND GROUND RULES USED IN NUCLEAR WASTE PROJECTIONS AND SOURCE TERM DATA

S. N. Storch and B. E. Prince Sep. 1979 137 p (Contracts W-7405-eng-26; DE-AC06-76PL-01830) (ONWI-24) Ayail: NTIS HC A07/MF A01

Assumptions and ground rules of long term domestic commercial nuclear waste projections published by two sources are compared. Target capacity growths associated with these projections range from 183 to 570 GW(e) for the year 2000. Each study regards the once through (no recycle) fuel cycle as a reference case. Fuel cycles employing reprocessing and various recycle strategies were also considered. The studies are compared

with respect to characteristics and packaging/shipment features of spent fuel and wastes generated from reprocessing and other fuel cycle activities. Issues associated with the interim storage of spent fuel are discussed along with the characteristics and issues relating to ore mill tailings and non-fuel cycle wastes. Assumptions and limitations associated with certain computer codes (viz., ORIGEN, KWIKPLAN, WASPR, and DISFUL) employed in the four waste projection studies are also outlined.

N80-32395\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THE ENERGY EFFICIENT ENGINE PROJECT Status Report

Lawrence E. Macioce, John W. Schaefer, and Neal T. Saunders 1980 42 p refs Presented at the Aerospace Congr., Los Angeles, 13-16 Oct. 1980

(NASA-TM-81566; E-531) Avail: NTIS HC A03/MF A01 CSCL 21E

The Energy Efficient Engine Project is directed at providing, by 1984, the advanced technologies which could be used for a generation of fuel conservative turbofan engines. The project is conducted through contracts with the General Electric Company and Pratt and Whitney Aircraft. The scope of the entire project and the current status of these efforts are summarized. A description of the preliminary designs of the fully developed engines is included and the potential benefits of these advanced engines, as well as highlights of some of the component technology efforts conducted to date, are discussed.

## N80-32731# Brookhaven National Lab., Upton, N. Y. SOOT REDUCTION IN DIESEL ENGINES BY CATALYTIC EFFECTS

R. Sapienza, T. Butcher, C. Krishna, and J. Gaffney 1980 20 p refs Presented at 4th Workshop on Catalytic Combust., Cincinnati, 14-15 May 1980: sponsored by EPA

(Contract DE-AC02-76CH-00016)

(BNL-27792; CONF-800553-2)

Avail: NTIS

HC A02/MF A01

Small additions of alcohols to the fuel and the presence of platinum surfaces in the combustion chamber can reduce soot emissions in a diesel engine. Tests were conducted over a limited range of operation in a single cylinder CFR engine. Most of the testing was done using pure cetane as a fuel at constant speed and load. Possible major features of the reaction mechanisms for both fuel additives and surface catalyst effectiveness are presented.

# N80-32733# Porsche (Ferdinand) AG, Stuttgart (West Germany). REDUCTION OF FUEL CONSUMPTION BY THERMODYNAMIC OPTIMIZATION OF THE OTTO MOTOR: COMPARATIVE INVESTIGATION OF OTTO DIESEL ENGINES

D. Gruden, R. Hahn, and H. Loercher 1980 171 p refs In GEORGIAN

(EUR-6711-DE) Avail: NTIS (US Sales Only)HC A08/MF A01; DOE Depository Libraries

Test on a 2 1 Otto engine for the Porshe 924 demonstrate that by optimizing the compression ratio, combustion chamber shape, fuel air ratio and ignition timing, it is possible to reduce the fuel consumption over the entire load and speed range from 4 to 30% in comparison with the conventional variant, without losing maximum power output. The compression ratio of the new engine is 13.0, and is operated with lean fuel/air mixture in the part load range. The acceleration time from 0 to 100 km/h is 9.7 s for the Otto variant, and 24.7 s for the diesel engine. The fuel consumption of both variants is about identical in mixed traffic conditions (city, road, highway). Exclusively in city driving (ECE-test) the diesel engine has a 9% better fuel consumption than the Otto engine due to its lower idle fuel consumption. At higher speeds (90 and 120 km/h), the fuel consumption of the thermodynamically optimized Otto engine is 2 to 8% lower. DOE

N80-32734# Transportation Systems Center, Cambridge, Mass.
POTENTIAL OF DIESEL ENGINE, 1979 SUMMARY SOURCE
DOCUMENT Final Report

Thomas Trella Mar. 1980 166 p refs Sponsored by National

Highway Traffic Safety Administration 5 Vol. (PB80-193659; DOT-TSC-NHTSA-79-38; DOT-HS-805130) Avail: NTIS HC A08/MF A01 CSCL 21E

The fuel economy potential of diesel engines in future passenger cars and light trucks was assessed. The primary technologies evaluated included: engine control strategy and implementation, the engine design variables, emissions and noise, fuels, lubricants, vehicle-engine matching, and the effects of vehicle characteristics. The major findings are summarized.

#### N80-32735# Transportation Systems Center, Cambridge, Mass. POTENTIAL OF DIESEL ENGINE, EMISSION TECHNOLOGY Final Report

Joseph Sturm and Thomas Trella Mar. 1980 47 p refs Sponsored by National Highway Traffic Safety Administration

(PB80-192685: DOT-TSC-NHTSA-79-40: DOT-HS-805239) Avail: NTIS HC A03/MF A01 CSCL 21E

Diesel engine emission technologies applicable to passenger cars and light trucks were surveyed. The general design and operating features are presented and discussed. Current and state-of-the-art concepts were reviewed with the focus on control of diesel emissions through modification of the combustion process, aftertreatment systems and fuel modifications.

#### N80-32736# Transportation Systems Center, Cambridge, Mass. POTENTIAL OF SPARK IGNITION ENGINE, EFFECT OF VEHICLE DESIGN VARIABLES ON TOP SPEED, PERFORMANCE, AND FUEL ECONOMY Final Report

Ralph W. Zub, Carol M. Neckyfarow, William M. Lew, and Ralph G. Colello Mar. 1980 86 p refs Sponsored by National Highway Traffic Safety Admistration 4 Vol. (PB80-191836; DOT-TSC-NHTSA-79-53; DOT-HS-805133) Avail: NTIS HC A05/MF A01 CSCL 21E

The effect of vehicle characteristics on vehicle performance and fuel economy was evaluated. Computer simulation offers repeatability and can predict minute changes in fuel economy based on relatively small vehicle alterations. The degree to which each vehicle parameter is modified is based upon projections presented in current literature. The results are assessed and an explanation of the interaction of the vehicle design characteristics on performance is presented.

N80-32827\*# Jet Propulsion Lab., California Inst. of Tech.,

#### A METHODOLOGY FOR THE ENVIRONMENTAL ASSESS-MENT OF ADVANCED COAL EXTRACTION SYSTEMS

Patrick J. Sullivan, Charles F. Hutchinson, Jeanne Makihara, and Jill Evensizer 15 Jun. 1980 204 p refs

(Contracts NAS7-100; ET-75-I-01-9036)

(NASA-CR-163570; JPL-Pub-79-82) NTIS Avail:

HCA10/MFA01 CSCL08I

Procedures developed to identify and assess potential environment impacts of advanced mining technology as it moves from a generic concept to a more systems definition are described. Two levels of assessment are defined in terms of the design stage of the technology being evaluated. The first level of analysis is appropriate to a conceptual design. At this level it is assumed that each mining process has known and potential environmental impacts that are generic to each mining activity. By using this assumption, potential environmental impacts can be identified for new mining systems. When two or more systems have been assessed, they can be evaluated comparing potential environmental impacts. At the preliminary stage of design, a systems performance can be assessed again with more precision. At this level of systems definition, potential environmental impacts can be analyzed and their significane determined in a manner to facilitate comparisons between systems. At each level of analysis, suggestions calculated to help the designer mitigate potentially harmful impacts are provided. ARH

N80-32867# Bechtel National, Inc., San Francisco, Calif.
COMBINED CYCLE SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEM STUDY. VOLUME 1: EXECUTIVE **SUMMARY Final Technical Report** 

Nov. 1979 111 p refs (Contracts ET-78-C-03-2051; DE-AC03-78ET-21050) (DOE-ET-21050/1-1) Avail: NTIS HC A06/MF A01

The major effort of the project was development and assessment of a commercial scale power plant concept where both solar energy and fossil fuel are used to generate electricity. This so called hybrid concept was developed around a combined cycle gas turbine/steam turbine power plant. A market analysis, and parametric and system studies were included leading to a comparative evaluation of the Modified Strawman and Advanced Strawman systems. DOE

#### N80-32868# Bechtel National, Inc., San Francisco, Calif. COMBINED CYCLE SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEM STUDY, VOLUME 2 Final Technical Report

Nov. 1979 491 p refs (Contracts ET-78-C-03-2051; DE-AC03-78ET-21050) (DOE-ET-21050-1-2) Avail: NTIS HC A21/MF A01

The conceptual design for a commercial scale (nominal 100 MWe) central receiver solar/fossil fuel hybrid power system with combined cycle energy conversion was developed. A near term, metallic heat pipe receiver and an advanced ceramic tube receiver hybrid system are defined through parametric and market potential analyses. Energy storage is not required and analyses show no economic advantages with energy storage provisions. It is concluded that the near term solar hybrid system is a cost effective alternative to conventional gas turbines and combined cycle generating plants, and has potential for intermediate load market penetration at 15% annual fuel escalation rate. Due to their flexibility, simple solar/nonsolar interfacing, and short startup cycles, these hybrid plants have significant operating advantages. Utility company comments suggest that hybrid power systems will precede stand-alone solar plants. DOF

#### N80-32870# BDM Corp., McLean, Va. PHOTOVOLTAIC APPLICATIONS DEFINITION AND PHOTOVOLTAIC SYSTEM DEFINITION STUDY IN THE AGRICULTURAL SECTOR. VOLUME 2: TECHNICAL RESULTS

R. W. Mengel, T. P. Nadolski, D. C. Sparks, S. K. Young, and A. Yingst May 1980 230 p Prepared for Sandia Labs., Albuquerque, N. Mex.

(Contract DE-AC04-76DP-00789) (SAND-79-7018/2-Vol-2) Avail: NTIS HC A11/MF A01

This volume describes the technical results of the study of potential photovoltaic (P/V) applications in US agriculture. The results presented address all technical aspects of the program and include a summary of agricultural energy consumption. The objectives of the technical effort reported were to: (1) identify and characterize agricultural energy demands that can effectively use P/V power systems: (2) develop effective P/V system designs for the four most promising applications; (3) determine performance and cost estimates for the designs; and (4) recommend systems for early test and demonstration and critical issues requiring further systems studies. The farms chosen for conceptual design include; (1) poultry layer farm, (2) hog production farm,

#### N80-32871# Oak Ridge National Lab., Tenn. Energy Div. COMPARISON OF SOLAR-THERMAL AND FOSSIL TOTAL-ENERGY SYSTEMS FOR SELECTED INDUSTRIAL **APPLICATIONS**

Gerald D. Pine Jun. 1980 75 p refs (Contract W-7405-eng-26)

(ORNL/TM-7022) Avail: NTIS HC A04/MF A01

(3) beef feedlot, and (4) year round vegetable farm.

Economic analyses of a conventional system and total energy systems based on phosphoric acid fuel cells, diesel piston engines, and central receiver solar thermal systems were performed for each of four industrial applications; a concrete block plant in Arizona, a fluid milk processing plant in California, a cugar beet processing plant in Colorado, and a meat packing plant in Texas. A series of sensitivity analyses was performed to show the effects of variations in fuel price, system size, cost of capital, and system initial cost. Solar total energy systems (STES) are more capital intensive than the other systems, and significant economies of

scale are associated with the STES. If DOE solar system cost goals are met. STES can compete with the other systems for facilities, with electrical demands greater than two or three megawatts, but STES are not competitive for smaller facilities. Significant energy resource savings, especially of oil and gas, resulted from STES implementation in the four industries. DOE

N80-32874# Lincoln Lab., Mass. Inst. of Tech., Lexington.
RESIDENTIAL PHOTOVOLTAIC FLYWHEEL STORAGE SYSTEM PERFORMANCE AND COST

R. D. Hay, A. R. Millner, and P. O. Jarvinen 1980 6 p refs Presented at the 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 18-22 Aug. 1980 (Contract DE-AC02-76ET-20279)

(DOE/ET-20279/92; CONF-800806-22)

HC Á02/MF AÓ1

A subscale prototype of a flywheel energy storage and conversion system for use with photovoltaic power systems of residential and intermediate load-center size was designed, built and tested. System design, including details of such key components as magnetic bearings, motor generator, and power-conditioning electronics, are described. Performance results of prototype testing are given and indicate that this system is the equal of or superior to battery and inverter systems for the same application. Results of cost and user-worth analysis show that residential systems are economically feasible in stand-alone and in utility-interactive applications.

N80-32880# Oak Ridge National Lab., Tenn. Energy Div. ANNUAL CYCLE ENERGY SYSTEM (ACES) Performance Report, Nov. 1977 - Sep. 1978

A. S. Holman and L. A. Abbatiello May 1980 77 p refs (Contract W-7405-eng-26)

(ORNL/CON-42) Avail: NTIS HC A05/MF A01

A single family residence near Knoxville. Tennessee, is being used to demonstrate the energy conserving features of the annual cycle energy system (ACES), an integrated heating and cooling system that utilizes a unidirectional heat pump and low temperature thermal storage. A second house, the control house, is being used to compare the performance of the ACES with that of an electric resistance heating and hot water system combined with a central air conditioning system. The ACES reduced peak utility system demands significantly: a reduction from 11:7 to 3.1 kW was achieved in the winter and from 4.1 to 0.7 kW in the summer. The only problems encountered were a heat leak into the storage bin that was twice the calculated value and control logic errors that produced excessive hot water in the winter, requiring extensive use of the night heat rejection mode in the summer. These problems are currently being corrected.

N80-32883# Brookhaven National Lab., Upton, N. Y. Technology Assessment Group.

REFERENCE ENERGY SYSTEMS AS APPLIED TO REGION-AL ENERGY POLICY

A. Hermelee Dec. 1979 26 p refs

(Contract EY-76-C-02-0016)

(BNL-26987) Avail: NTIS HC A03/MF A01

Reference Energy Systems (RES) was developed for the region serviced by the Tennessee Valley Authority for a base time period and projections developed for the years 1985 and 2000. The RES is a network representation of the technical activities required to supply various forms of energy to end-use activities. Technologies are defined for all operations involving specific fuels including resource extraction, refinement, conversion, transportation, distribution, and utilization. The impact of a new technology in terms of resource consumption may be evaluated by modifying the energy flow paths in a region to incorporate the new technology. Alternate paths through the network reflect the substitutability of resources and technologies for one another.

DOE

N80-32888# Midwest Research Inst., Golden, Colo. PLANNING FOR ELECTRIC UTILITY SOLAR APPLICA- TIONS: THE EFFECTS ON RELIABILITY AND PRODUCTION COST ESTIMATES OF THE VARIABILITY IN DEMAND

George R. Fegan and C. David Percival Jan. 1980 14 p refs Presented at the ASME Century 2 Emerging Technol. Conf., San Francisco, 10 Aug. 1980

(Contract DE-AC02-76CH-00178)

(SERI/TP-351-545; CONF-800804-18) Avail:

HC A02/MF A01

Previous studies showed the necessity for the consideration of hourly variability in the output from the intermittent generation source. However, the studies did not take into account the variability in the demand. A result is presented which shows that under general conditions the variability due to randomness can be ignored except in the neighborhood of the peak and minimum demands.

N80-32893# Bechtel National, Inc., San Francisco, Calif.
COMBINED CYCLE SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEM STUDY. VOLUME 3: APPENDICES Final **Technical Report** 

Nov. 1979 177 p refs

(Contract' ET-78-C-03-2051)

(DOE/ET-21050/1-3-Vol-3) Avail: NTIS HC A09/MF A01

A design study for a 100 MW gas turbine/steam turbine combined cycle solar/fossil fuel hybrid power plant is presented. The appendices contain: (1) preconceptual design data: (2) market potential analysis methodology: (3) parametric analysis methodology: (4) EPGS system description; (5) commercial-scale solar hybrid power system assessment; and (6) conceptual design data

N80-32901# Brookhaven National Lab., Upton, N. Y. , National Center for Analysis of Energy Systems.

SIMULATION MODEL FOR ASSESSING BUILDING **ENERGY-CONSERVATION POLICIES** 

Peter T. Kleeman. May 1980 13 p refs. Presented at 11th Ann. Conf. on Modeling and Simulation, Pittsburgh, 1-2 May,

(Contract DE-AC02-76CH-00016)

(BNL-27802; CONF-800549-2)

HC A02/MF A01

Avail: NTIS

NTIS

A multiple-region simulation model for estimating economic, environmental, and energy-related impacts of building energyconservation policies is presented. The model is formulated as a time-stepped sequence of optimization subproblems, each reflecting building energy-conservation options and energy costs, and identifying optimal investments and energy consumption for the time step.

N80-32904# Oak Ridge National Lab., Tenn. Energy Div. THEORY AND DESIGN OF AN ANNUAL CYCLE ENERGY SYSTEM (ACES) FOR RESIDENCES .

E. A. Nephew, L. A. Abbatiello, and M. L. Ballou May 1980 357 p refs

(Contract W-7405-eng-26)

(ORNL/CON-43) Avail: NTIS HC A16/MF A01

The basic concept of the Annual Cycle Energy System (ACES), and integrated system for supplying space heating, hot water, and air conditioning to a building, and the theory underlying its design and operation are described. Practical procedures for designing an ACES for a single family residence, together with recommended guidelines for the construction and installation of system components, are presented. Methods are discussed for estimating the life cycle cost, component sizes, and annual energy consumption of the system for residential applications in different climatic regions of the US. DOE

Energy N80-32905# Honeywell, Inc., Minneapolis, Minn. Resources Center.

ECONOMIC EVALUATION OF THE ANNUAL CYCLE ENERGY SYSTEM (ACES). VOLUME 1: EXECUTIVE SUMMARY Final Report

May 1980 70 p

(Contract W-7405-eng-48)

(ORNL/Sub-7470/1-V1) Avail: NTIS HC A04/MF A01

Three different classes of building are investigated, namely: single family residence; multifamily residence: and commercial office building. For each building type in each geographic location, the economic evaluation of the annual cycle energy system (ACES) is based on a comparison of the present worth of the ACES to the present worth of a number of conventional systems. The results of this analysis indicate that the economic viability of the ACES is very sensitive to the assumed value of the property tax, maintenance cost, and fuel escalation rates, while it is relatively insensitive to the assumed values of other parameters. Fortunately, any conceivable change in the fuel escalation rates would tend to increase the viability of the ACES concept. An increase in the assumed value of the maintenance cost or property tax would tend to make the ACES concept less viable; a decrease in either would tend to make the ACES concept more viable.

DO

N80-32909# California Univ., Livermore. Lawrence Livermore

#### ENERGY AND TECHNOLOGY REVIEW

Jun. 1980 19 p.

(Contract W-7405-eng-48)

(UCRL-52000-80-6) Avail: NTIS HC A02/MF A01

A promising technique for detecting and quantifying the effects of cancer-causing agents in human somatic cells was developed. Using argon X-ray line imaging to measure the ion density of deuterium tritium fuel in an inertial confinement fusion target at the instant of ignition is described. The potential effects on the economy of a complete cutoff of Middle Eastern oil and how we might cope with them are discussed.

## N80-32911# Midwest Research Inst., Golden, Colo. POTENTIAL FOR SUPPLYING SOLAR THERMAL ENERGY TO INDUSTRIAL UNIT OPERATIONS

E. Kenneth May Apr. 1980 13 p refs Presented at the 89th Ann. Meeting of AICE, Portland, Oreg., 17-20 Aug. 1980 (Contract DE-AC02-77CH-00178)

(SERI/TP-632-584; CONF-800802-3) Avail: NTIS

HC AO2/MF AO1

Adoption of solar thermal technology, considered in terms of the end use of energy delivered to industrial unit operations was studied. The use of low temperature processes, which are more easily integrated with solar thermal technology were studied. The adoption of solar technology is favored by the relative rates of increase of the costs of electricity and natural gas, and by energy conservation measures. High temperature hot water systems are more compatible with solar technology.

N80-32918# Department\*of Energy, Washington, D. C. Office of Current Reporting.

#### INTERNATIONAL ENERGY INDICATORS

Jun. 1980 40 p

(DOE/IA-0010) Avail: NTIS HC A03/MF A01

Data on the crude oil capacity, production, and shut in of several countries are presented. Petroleum consumption by industrial countries is reported. Natural gas development throughout the world is reported. World reserves of crude oil and natural gas were estimated.

T.M.

# N80-32958# Oak Ridge National Lab., Tenn. Energy Div. APPRAISAL OF THE M FACTOR AND THE ROLE OF BUILDING THERMAL MASS IN ENERGY CONSERVATION K. W. Childs Jul. 1980 51 p refs (Contract W-7405-eng-26)

(ORNL/CON-46) Avail: NTIS HC A04/MF A01

A concept in heat transfer calculations known as the M factor was introduced to account for thermal storage due to mass in building walls. The assumptions behind the development of the M factor are reviewed. The effect of mass in walls on seasonal or annual energy transmission through walls is examined, as well as the applicability of the M factor as a correction to account for any mass effects. In connection with the effect of mass on seasonal energy consumption, the use of an M factor

correction when checking a building for compliance with energy conservation standards is investigated. The suitability of applying the M factor correction to the peak load determined by a steady state calculation for equipment sizing is also explored. In addition, the relationship of thermal mass to other parameters that determine loads and energy consumption is investigated, and the role of thermal mass in energy conservation is discussed.

DOF

## N80-32963# California Energy Commission, Sacramento. ENVIRONMENTAL IMPLICATIONS OF ELECTRIC UTILITY SUPPLY PLANS, 1978-2000 Final Report

Tom MacDonald May 1980 109 p refs (PRRO-192156: CAFC-64: CAFC-300-80-

(PB80-192156; CAEC-64; CAEC-300-80-005) Avail: NTIS HC A06/MF A01 CSCL 10B

The results of the environmental assessment of the current electricity supply plans of the California utilities are presented. Major areas of assessment were construction and operation of electric generation facilities, including air quality, land use, and solid waste disposal. Maps show the locations of utility proposed generation facilities and potential siting areas for additional facilities. Methods used to designate potential siting areas based on a statewide siting assessment are discussed.

N80-32964# Bureau of Commercial Fisheries, Ann Arbor, Mich. Biological Services Program.

## PROCEEDINGS OF THE CLEMSON WORKSHOP ON ENVIRONMENTAL IMPACTS OF PUMPED STORAGE HYDROELECTRIC OPERATIONS

James P. Clugston, ed. Apr. 1980 214 p refs Workshop held in Clemson, S. C., 15-16 May 1979

(PB80-192453: FWS/OBS-80/28) HC A10/MF A01 CSCL 10B Avail: . NTIS

The pumping of water to a high reservoir for storage during periods of low power demand, so that it can be used for the generation of electricity during peak power demand was discussed. Papers which were presented exchanged ideas and data with regard to the environmental impact of this regular interchange of water.

L.F.M.

N80-32972# Brookhaven National Lab., Upton, N. Y. Process Sciences Div.

## ENVIRONMENTAL CONTROL TECHNOLOGY FOR CARBON DIOXIDE Final Report

Anthony S. Albanese and Meyer Steinberg May 1980 30 p refs

(Contract DE-AC02-76CH-00016)

(DOE/EV-0079) Avail: NTIS HC A03/MF A01

The impact of fossil fuel use in the US on worldwide CO2 emissions and the impact of increased coal utilization on CO2 emission rates are assessed. The aspects of CO2 control are discussed as well as the available CO2 removal sites. The primary factor affecting the practicability of a CO2 control system is its energy requirements. At a CO2 removal efficiency of 50%, the power generation efficiency of a conventional coal fired power plant would be reduced from 34% to about 25%, and the cost of power generation would be expected to double. For 90% CO2 removal, power generation efficiency is reduced to between 15 and 6% and the cost of power generation increases by a factor of from 4 to 7.

## N80-32973# Los Alamos Scientific Lab., N. Mex. ASSESSMENT OF ENVIRONMENTAL CONTROL TECHNOL. OGIES FOR ENERGY STORAGE SYSTEMS, 1979

M. C. Krupka, J. E. Moore, W. E. Keller, G. A. Baca, R. I. Brasier, and W. S. Bennett Apr. 1980 123 p refs (Contract W-7405-eng-36)

(LA-8308-MS) Avail: NTIS HC A06/MF A01

Environmental impacts are identified, control techniques are described and recommendations for needed control technology are made. The storage technologies investigated include: lead acid battery, hydroelectric pumped, superconducting magnet, compressed air, flywheel and thermal. Environmental impacts of fuel cell technology is also presented. Although not strictly energy storage devices, many of the benefits attributed to fuel cells are

similar to those of the other storage systems. In addition, sections on new applications for energy storage technologies and the additional costs of controls to be used for mitigation of certain adverse impacts are also presented. Detailed discussion of the various environmental impacts as they relate to primarily operational situations are emphasized.

N80-32974# Stuttgart Univ. (West Germany). Inst. für Kernenergetik und Energiesysteme

SIMULATION OF THE ENERGY-INDUSTRY-ENVIRONMENT SYSTEM FOR LIMITED ECONOMIC REGIONS, USING THE EXAMPLE OF BADEN-WUERTTEMBERG. PART 1: DATA, MODEL DEVELOPMENT ADAPTATION Progress Report, 1960 1974 [SIMULATION DES SYSTEMS ENERGIE-WIRTSCHAFT-UMWELT FUR BEGRENZTE WITSCHAFTS-RAUME AM BEISPIEL BADEN-WURTTEMBERGS ZUS-AMMENFASSENDER SCHLUSSBERICHT]

K. H. Hoecker and H. Unger Oct. 1979 105 p refs In GERMAN

(IKE-K-54-20-Pt-1) Avail: NTIS (US Sales Only) HC A06/MF A01: DOE Depository Libraries

The structure and development of the Baden-Wuerttemberg power industry is analyzed and these data are compared with the data for West Germany. On the producer side, there are especially the electric power industry and the petroleum industry; on the consumer side, there are the usual sectors of private households and small consumers, industry, and transportation. The development of the past power supply structure is analyzed, and the analysis is used as a basis for a forecast. The model structure and methods are described.

DOE

N80-32983# Oak Ridge Associated Universities, Tenn. Inst. for Energy Analysis.

### CONSTRAINTS ON CARBON DIOXIDE PRODUCTION FROM FOSSIL FUEL USE

Ralph M. Rotty and Gregg Marland May 1980 37 p refs (Contract DE-AC05-760R-00033)

(ORAU/IEA-80-9(M)) Avail: NTIS HC A03/MF A01

The exponential growth of fossil fuel use over recent decades has resulted in a 4.3% annual increase in the carbon dioxide emitted to the atmosphere. Three types of possible constraints to limit the use of fossil fuels and the subsequent production of CO2 are discussed: resource contraints; fuel demand constraints; and environmental constraints. An analysis of the next 50 years suggests that resource constraints will not provide severe limits. Fuel demand constraints will probably limit the use of fossil fuels to levels that keep the atmospheric carbon dioxide concentration below 450 ppM(v) for the next 50 years, so that the impacts of atmospheric carbon dioxide will not cause mankind to take action soon. In spite of this conclusion a continuing, long term problem is foreseen and full efforts to understand and continually monitor the CO2 problem should be made and alertness to any changes that may require action should be maintained. DOE

N80-32987# Systems Science and Software, San Diego, Calif. Energy Analaysis and Environmental Div.

#### ORGANIC MATERIAL EMISSIONS FROM HOLDING PONDS AT COAL-FIRED POWER GENERATION FACILITIES Final Report

A. E. Rosecrance and B. N. Colby Mar. 1980 80 p refs (EPRI-EA-1377; TPS-78-826) Avail: NTIS HC A05/MF A01

A literature survey of organic chemical emissions from holding or ash ponds which are used by most coal fired utilities to collect process waste materials was conducted. Approximately 140 Kg/day of organic material is predicted to be present in surface runoff of a hypothetical 1000 MW facility of which only 3.5 Kg/day or 2.6% of the total, is accounted for by specific compounds. Of the compounds identified, only phenol is near a level (97 microngram/1) of potential environmental significance. A survey of known holding pond influents was undertaken to assess which processes were most likely to be associated with the organic chemical content of the pond. Of the process wastes directed into the pond, cooling tower blowdown, water treatment wastes and boiler blowdown are identified as the major

contributors of organic material. Organic chemical additives, which are used to control bacterial buildup, scale formation, pitting, corrosion, pH stability, and solid dispersion, account for approximately 96% of the organic pond influents

DOE

N80-32988# Department of Energy, Washington, D. C. Office of Buildings and Community Systems.

ENVIRONMENTAL ASSESSMENT. ENERGY EFFICIENCY STANDARDS FOR CONSUMER PRODUCTS Technical Support Document

Jun. 1980 137 p refs

(DOE/CS-0168; TSD-2) Avail: NTIS HC A07/MF A01

The Consumer Products Efficiency Standards (CPES) program covers: refrigerators and refrigerator-freezers, freezers, clothes dryers, water heaters, room air conditioners, home heating equipment, kitchen ranges and ovens, central air conditioners (cooling and heat pumps), furnaces, dishwashers, television sets, clothes washers, and humidifiers and dehumidifiers. DOE proposed standards for eight of the products covered by the Program in a Notice of Proposed Rulemaking. DOE expects to propose standards for home heating equipment, central air conditioners (heat pumps only), dishwashers, television sets, clothes washers, and humidifiers and dehumidifiers in 1981. No significant adverse environmental or socioeconomic impacts were found to result from instituting the CPES.

N80-32989# Department of Energy, Washington, D. C. Div. of Environmental Control.

## ENVIRONMENTAL-CONTROL-TECHNOLOGY ACTIVITIES OF THE DEPARTMENT OF ENERGY IN FY 1979

Jun. 1980 99 p refs

(DOE/EV-0084) Avail: NTIS HC A05/MF A01

Background material that contributes to the capability to evaluate and assess the environmental control accomplishments, issues, gaps, and overlaps associated with energy development within DOE, in conjunction with other agencies, and in the private sector is presented. A measure of the change in emphasis in the environmental control technology activities within DOE is also presented, indicating shifts, if any, in funding levels for each of the energy technologies. Total DOE FY 1979 budget outlay allocated to environmental control activities was \$421,533. 000 or 5.0% of the total FY 1979 DOE budget. The inputs received from the energy technology areas are summarized. These inputs were submitted in accordance with a description of environmental control related activities, which are those activities directed at research, development, and demonstration of processes, procedures, systems, subsystems, and strategies that directly or indirectly eliminate, minimize, or mitigate environmental impacts.

N80-32995# Radian Corp., Austin, Tex.

ENVIRONMENTAL ASSESSMENT REPORT: WELLMAN-GALUSHA LOW-BTU GASIFICATION SYSTEMS Final Report, May 1978 - Sep. 1979

Pat Murin, Theresa Sipes, and G. C. Page May 1980 309 p refs

(Contract EPA-68-02-2147)

(PB80-190796: EPA-600/7-80-093) Avail: NTIS HC A14/MF A01 CSCL 07A

An overview of Wellman-Galusha gasification systems, including estimates of the systems' energy conversion efficiencies and capital and operating costs is given. It provides data characterizing the systems' input materials, process streams, products, byproducts, and multimedia discharges. It identifies pollution control alternatives for the multimedia discharges and toxic substances in the systems' products and byproducts, and estimates their costs and energy impacts. It assesses regulatory requirements for the environmental impacts of the systems. It gives data needs and recommendations for obtaining those data.

N80-32997# Illinois Univ. at Urbana-Champaign, Urbana. Dept. of Agronomy.

SORPTION PROPERTIES OF SEDIMENTS AND ENERGY-

#### 01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

### RELATED POLLUTANTS Final Report, Jul. 1977 - Dec.

John J. Hassett, Jay C. Means, Wayne L. Banwart, and Susanne G. Wood Apr. 1980 50 p refs Prepared in cooperation with Maryland Univ., Solomons

(Contract EPA-68-03-2555)

(PB80-189574; EPA-600/3-80-041)

HC A03/MF A01 CSCL 07D

The factors that determine the extent of sorption of organic compounds that are representative of coal conversion waste streams are described. The compounds, all radiolabeled, were acetophenone: 1-naphthol; pyrene; 7,12-dimethylbenz(a) anthracene: 3-methylcholanthrene; dibenz(a,h)anthracene; acridine: 2,2'-biquinoline: 13H-dibenzo(a,i)carbazole; dibenzothiophene; benzidine; 2-aminoanthracene; 6-aminochrysene; and anthracene-9-carboxylic acid. Batch equilibrium isotherms were determined for each compound on 14 sediments and soils that had been collected from the Missouri, Illinois, Mississippi, and Ohio rivers and their watersheds. Laboratory procedures for determining octanol water partition coefficients and water solubilities were developed and then performed on the compounds. The sorption constants were correlated with soil and sediment properties and with the water solubilities and octanol water partition coefficients of the compounds.

N80-33018# Environmental Protection Agency, Ann Arbor, Mich. Inspection and Maintenance Staff.

#### EFFECTS OF GASOHOL ON IDLE HC AND CO EMIS-SIONS

Thomas Darlington and Richard Lawrence Mar. 1980 19 p

(PB80-190655; EPA-AA-IMS/ST-80-4; TEB-80-13) Avail: NTIS HC A02/MF A01 CSCL 13B

A test program was run to investigate the effects of gasohol on CO and HC emissions on an I/M idle test. Three vehicles were set up to operate on either gasoline or gasohol. A Hamilton emissions analyzer was used to measure tailpipe emissions. CO emissions were varied in each of the cars by adjusting the idle mixture screw, and HC emissions were varied by inducing a misfire with a misfire generator. At each CO and HC value as specified in the program, the fuel was switched from gasoline to gasohol while its effect was noted on tailpipe emissions. The data obtained provided a basis for determining gasohol's ability to reduce CO and HC emissions for an idle test. GRA

N80-33167# Wayne State Univ., Detroit, Mich. Mechanical Engineering.

#### BASIC RESEARCH IN ENGINEERING: PROCESS AND SYSTEMS DYNAMICS AND CONTROL HIGH PRIORITY RESEARCH NEEDS RELEVANT TO ENERGY

M. J. Rabins, T. F. Edgar (Texas Univ. at Austin), H. H. Richardson (MIT, Cambridge), and J. Zaborszky (Washington Univ., Seattle) Feb. 1980 162 p. refs. Workshop held at Denver, 20-23 Jun. 1979; sponsored by Am. Automatic Control Council, ASME and Engineering Societies Commission on Energy, Inc. (Contract EF-77-C-01-2468)

(FE-2468-65) Avail: NTIS HC A08/MF A01

Process and Systems Dynamics and Control (PSDC) is concerned with the development and control of system behavior, performance criteria, and theories of control and optimization. A set of high-priority basic engineering research needs in the PSDC field which are important to the development of future energy technologies. The ten high priority generic research areas were aggregated into four major research needs recommended for DOE support; on-line optimization and control, systems methodology, measurements methodology and instrumentation, and modeling.

N80-33288# General Energy Associates, Cherry Hill, N.J. RELEVANCE OF THE SECOND LAW OF THERMODY-NAMICS TO ENERGY CONSERVATION

Jan. 1980 37 p refs (Contract DE-AT01-79CS-40178) (DOE/CS-40178/01-Vol-1) Avail: NTIS HC A03/MF A01

An analysis is presented of the potential relevance of the use of analytical tools based on the second law of thermodynamics to existing federal programs for energy conservation in the industrial, transportation, building, and utility sectors in the US. DOE

N80-33446\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena

#### **DEEP SPACE NETWORK ENERGY PROGRAM**

S. E. Friesema In its The Telecommun. and Data Acquisition Rept. 15 Oct. 1980 p 145-149 refs

Avail: NTIS HC A08/MF A01 CSCL 14B

If the Deep Space Network is to exist in a cost effective and reliable manner in the next decade, the problems presented by international energy cost increases and energy availability must be addressed. The Deep Space Network Energy Program was established to implement solutions compatible with the ongoing development of the total network. E.D.K.

N80-33580# Committee on Science and Technology (U. S. House).

OVERSIGHT: ALTERNATE LIQUID FUELS TECHNOLOGY Washington GPO 1979 722 p refs Hearings before the Subcomm. on Energy Develop, and Appl. of the Comm. on Sci. and Technol., 76th Congr., 1st Sess., no. 33, 5-7 Jun. 1979 (GPO-50-313) Avail: SOD

Testimony is provided on alternate liquid fuels for petroleum. and their role in furthering independence from foreign imported oil. Two facets of the problem considered are economic security with respect to transportation fuels for the civilian sector, and mobility fuels for the national defense apparatus. Commercial synthetic liquid fuels technologies are emphasized. JMS

N80-33581# Committee on Science and Technology (U. S. House)

OVERSIGHT: COST ESTIMATION TECHNIQUES FOR EMERGING SYNTHETIC **FUELS** TECHNOLOGY, VOLUME 9

Washington GPO 1979 49 p Joint hearings before the Subcomm. on Energy Develop. and Appl. of the Comm. on Sci. and Technol., the Subcomm. on Oversight and Invest, and the Subcomm. on Energy and Power of the Comm. on Interstate and Foreign Com., 96th Congr., 1st Sess., no. 34, 16 Jul. 1979 (GPO-51-721) Avail: SOD

The inherent uncertainties surrounding a crash program to commercialize synthetic fuels are discussed. Statements concerning the energy and other opportunities which would be foregone by a massive open ended commitment of capital to this particular option are presented. E.D.K.

#### N80-33593# R and D Associates, Marina Del Rey, Calif. PERSPECTIVES ON RESEARCH ON LNG VAPOR CLOUD DISPERSION

Allen L. Kuhl, H. J. Carpenter, F. R. Gilmore, and E. J. Chapyak (LASL) In Max-Planck Inst. fuer Stroemungsforsch. Discussion on Explosion Hazards Dec. 1979 p 90-99 refs

Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 20,70

Field experiments, wind tunnel simulations, and mathematical models of cloud dispersion are described. Field experiments were not useful for predicting vapor cloud characteristics from large spills. Considerable differences also exist between model results for large spills. The physical effects important to vapor cloud dispersion include gravity spreading, turbulence effects, inhibiting effects of the cold gas on turbulent mixing, and the nature of the atmospheric boundary layer. Further research is suggested with better models, scaled experiments, and wind tunnel tests to check scaling problems. Author (ESA)

N80-33595# Army Armament Research and Development Command, Dover, N. J.

## VAPOR CLOUD EXPLOSION STUDIES IN THE UNITED STATES

Norman Slagg and Paul A. Urtiew (California Univ., Livermore. Lawrence Livermore Lab.) In Max-Planck Inst. fuer Stroemungsforsch. Discussion on Explosion Hazards Dec. 1979 p 111-113

Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 20,70

Institutions and individuals involved in the liquefied natural gas problem and in large scale dust explosions are identified. Studies are being conducted which are concerned with the mechanisms of flame propagation, the acceleration of flames and dispersion problems under a variety of environmental conditions. Also included are risk analysis studies, unconfined explosions, two phase detonations, blast wave profiles, and dust explosions in coal mines. The technical problem areas can be divided up into the following: mechanisms which cause flame acceleration, initiation requirements, effect of fuel air ratio variations, the estimation of blast and other damage effects, scaling studies, particularly for the plume problem and also for flame acceleration mechanisms.

N80-33860\*# General Electric Co., Schenectady, N. Y. Energy Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA. PART 1: COAL-FIRED NOCOGENERATION PROCESS BOILER. SECTION A Final Report

W. F. Knightly May 1980 481 p refs Prepared for DOE 6 Vol.

(Contract DEN3-31)

(NASA-CR-159770-Pt-1; GE80ET0105-Vol-6-Pt-1;

DOE/NASA/0031-80/6) Avail: NTIS HC A21/MF A01 CSCL

Various advanced energy conversion systems (ECS) are compared with each other and with current technology systems for their savings in fuel energy, costs, and emissions in individual plants and on a national level. About fifty industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidates which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on-site gasification of coal. Computer generated reports of the fuel consumption and savings, capital costs, economics and emissions of the cogeneration energy conversion systems (ECS's) heat and power matched to the individual industrial processes are presented for coal fired process boilers. National fuel and emissions savings are also reported for each ECS assuming it alone is implemented. Author

N80-33861\*# General Electric Co., Schenectady, N. Y. COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA. PART 2: RESIDUAL-FIRED NOCOGENERATION PROCESS BOILER Final Report

W. F. Knightly May 1980 287 p

(Contract DEN3-31)

boilers.

(NASA-CR-159770-Pt-2; GE80ET0105-Vol-6-Pt-2;

DOE/NASA/0031-80/6-Vol-6-Pt-2)

Avail: NTIS

HC A13/MF A01 CSCL 10B

Computer generated data on the performance of the cogeneration energy conversion system are presented. Performance parameters included fuel consumption and savings, capital costs, economics, and emissions of residual fired process

**N80-33870**# Committee on Interstate and Foreign Commerce (U. S. House).

ENERGY POLICY: SUPPLY AND DEMAND ALTERNATIVES

Washington GPO 1980 97 p refs Hearing before the Subcomm. on Oversight and Invest. of the Comm. on Interstate and Foreign Com., 96th Congr., 1st Sess., 26 Jul. 1979 (GPO-56-541) Avail: Subcommittee on Oversight and Investigations

The international energy crisis and U.S. energy policy are discussed. Factors of supply and demand are evaluated and recommendations made for conserving energy and reducing dependence on foreign oil. Synthetic fuels and the processes of coal gasification and coal liquefaction are evaluated.

S.F.

N80-33871# Committee on Interstate and Foreign Commerce (U. S. House).

## INCENTIVES FOR ENERGY CONSERVATION

Washington GPO 1980 241 p refs Joint hearing before the Subcomm. on Oversight and Invest. of the Comm. on Interstate and Foreign Com., and the Subcomm. on the City of the Comm. on Banking, Finance and Urban Affairs, 96th Congr., 1st Sess., 26 Oct. 1979

(GPO-55-634) Avail: Subcommittee on Oversight and Investigations

Ways to make homes and workplaces more energy efficient were discussed. Due to rise in the average price of world crude oil, the need for across the board energy savings was stressed. Tax credit for conservation measures and solar installations was considered to favor the affluent and to discriminate against the poor. New York's program to achieve energy conservation was described. Conservation is considered to be a cheaper way of meeting the energy needs than building new generating plants or producing synthetic gas from coal.

R.K.G.

N80-33872# Committee on Science and Technology (U. S. House).

## OVERSIGHT: WIND ENERGY PROGRAM

Washington GPO 1979 190 p Hearing before the Subcommon Energy Develop and Appl. of the Common Sci. and Technol.

96th Congr., 1st Sess., no. 35, 30 Jul. 1979 (GPO-51-382) Avail: SOD

Testimony is presented on renewable energy sources with emphasis on the wind energy program. Efforts to develop numerous sizes of wind machines to serve various applications and to meet differing market requirements are highlighted. Wind energy is identified as having the highest potential of all the solar electric technologies to contribute sizable amounts of energy by the year 2000. The capability of the wind energy program to realize this potential is discussed.

## N80-33910# Department of Energy (US), London (England). WORKING GROUP ON FUEL CONSUMPTION TARGETS Interim Report

27 Jun. 1979 31 p

(NP-24333) Avail: NTIS (US Sales Only) HC A03/MF A01: DOE Depository Libraries

The UK Working Group on Fuel Consumption Targets was created in 1978 to investigate the feasibility of setting progressive targets for raising the average mpg achieved by new cars and methods of achieving these targets and to report to the Automotive Energy Consultative Group. The standards established for cars and the factors that influence the standards are discussed. Proposals for a voluntary fuel consumption targets scheme were submitted to the Working Group by representatives of the Society of Motor Manufacturers and Traders. The text of that scheme is given in annexes to the report.

N80-33922# Office of Technology Assessment, Washington, D. C.

CONSERVATION AND SOLAR ENERGY PROGRAMS OF THE DEPARTMENT OF ENERGY: A CRITIQUE Jun. 1980-81 p. refs

(PB80-197759: OTA-E-120: LC-80-600092) Avail: NTIS HC A05/MF A01: Also available HC SOD CSCL 10A

In response to a request from the House Committee on Science and Technology, DOE's solar and conservation goals and the strategies for meeting them are reviewed. Management

#### 01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

and institutional issues requiring DOE or Congressional attention are identified.

N80-33929# Council for Scientific and Industrial Research, Pretoria (South Africa).

INTERNATIONAL CONFERENCE ON AIR POLLUTION, VOLUME 1

25 Oct. 1979 389 p refs Conf. held at Pretoria, 22-25 Oct. 1979 4 Vol.

(ISBN-0-7988-16651) Avail: NTIS HC A17/MF A01

Various problems concerning air pollution and its effects and air pollution control are addressed. Specific topics include legislation, medical aspects, environmental planning, economic aspects, community administration, and public reaction.

NBO-33932# Electricity Commission of New South Wales, Sydney (Australia). Power Div.

COLLECTING FLY ASH FROM LOW SULPHUR COALS: AN OVERVIEW OF AUSTRALIAN EXPERIENCE

K. S. Watson. *In* CSIR. Intern. Conf. on Air Pollution, Vol. 1 25 Oct. 1979. 11 p.

Avail NTIS HC A17/MF A01

The performance and costs of precipitators and fabric filters when used with pulverized coal or spreader stoker fired boilers are compared. Economic consideration tend to favor fabric filters as target collection efficiency increases, particularly is fly ash of poor reduced plant availability due to premature bag failure from physical breakdown or from blinding increases in an unpredictable manner. Where lower collection efficiency is adeaute or where conditions fabor precipitation both capital and operating and maintenance charges are likely to put precipitators ahead on cost.

M.G.

N80-33939# Phillips Carbon Black Co. Ltd., Port Elizabeth (South Africa)

## ENERGY CONSERVATION-AIR POLLUTION ABATEMENT PROJECT

A. L. Mcl. Baillie In CSIR Intern. Conf. on Air Pollution, Vol. 2 25 Oct. 1979 9 p

Avail: NTIS HC A13/MF A01

An incineration project to eliminate the H2S from the effluent gasses of carbon black plants is described. A shift in focus to conversion of the waste heat in the incineration process to useful energy in the form of steam/elect:icity is discussed. The electricity generated in the energy conversion project is sufficient for the process needs of the carbon black plants as well as enough to sell to a neighboring industry.

J.M.S.

N80-33943# Council for Scientific and Industrial Research, Pretoria (South Africa).

## INTERNATIONAL CONFERENCE ON AIR POLLUTION, VOLUME 3

25 Oct. 1979 373 p. refs. Conf. held in Pretoria, 22-25 Oct. 1979 4 Vol.

(ISBN-0-7988-1665-1: ISBN-0-7988-1667-8) Avail: NTIS HC A16/MF A01

Various aspects of energy technology are considered in terms of their environmental implications. Particular attention is given to the monitoring and control of industrial pollutants in the atmosphere as well as the utilization of wastes as an energy alternatives.

N80-33951# Associated Octel Co. Ltd., Bletchley (England). Engine Lab

## ENERGY: CAREFUL CONSERVATION OR REGULATED WASTE

P. L. Dartnell *In CSIR* Intern. Conf. on Air Poliution, Vol. 3 25 Oct. 1979 25 p. refs

Avail: NTIS HC A16/MF A01

The progress of the passenger car power unit in the form

of the spark ignition engine and possible development of this engine in the future is discussed with respect to alternative forms of power units. The demand of environmental considerations particularly as they apply to control of exhaust emissions in various areas of the world are considered against the methods of control and the background of penalties incurred in fuel consumption. The reasons for excessively stringent regulations for vehicle exhaust emissions are challenged in relation to more moderate control which will permit optimizing both the engine and the production of the fuel supply for maximum energy utilization.

N80-33954# Council for Scientific and Industrial Research, Pretoria (South Africa).

## INTERNATIONAL CONFERENCE ON AIR POLLUTION, VOLUME 4

25 Oct. 1979 246 p refs Conf. held in Pretoria, 22-25 Oct. 1979 4 Vol.

Avail: NTIS HC A11/MF A01

Electrostatic precipitators, aerosol concentration determination, and air quality monitoring systems are discussed. Other topics include air quality simulation models and a review of the industrial role in pollution control.

N80-33955# Council for Scientific and Industrial Research, Pretoria (South Africa).

**ENVIRONMENT: THE ENERGY CONNECTION** 

H. Brown *In its* Intern. Conf. on Air Pollution, Vol. 4 25 Oct. 1979 16 p refs Avail: NTIS HC A11/MF A01

The adoption and maintenance of environmental controls is a costly exercise. In many cases it is necessary to use extra energy for afterburning and manufacture of new plants and equipment. This is particularly true in the case of electricity generating stations, cement works, steelworks, and control of motor car exhaust gases. The vast number of emissions from low level chimneys in energy, cash to the user and the general publis. It is increasingly evident that the benefits cannot be assessed solely in monetary terms in view of the important need to conserve energy stocks and improve the health of all people.

N80-33960# American Air Filter Co., Inc., Louisville, Ky.
ENVIRONMENTAL AIR QUALITY CONTROL FROM THE
INSIDE LOOKING OUT

Edwin B. Fieldhouse *In* CSIR Intern. Conf. on Air Pollution, Vol. 4 25 Oct. 1979 29 p

Avail: NTIS HC A11/MF A01

A clear understanding of and an analytical solution to the problems associated with pollution control requires a quantitative definition of pollution problems. Pollution reuction strategies based on material and energy flow information must be devised in order to improve plant or product system efficieny. Realisitic pollution control policies need to be established to meet conflicting goals such as employee demands, management guidelines, and government regulations. An understanding of what technology can and cannot contribute toward the maintenance of a healthy environment is also required.

N80-33969# Los Alamos Scientific Lab., N. Mex.
PRELIMINARY STUDY OF THE POTENTIAL ENVIRONMENTAL CONCERNS ASSOCIATED WITH SURFACE WATERS
AND GEOTHERMAL DEVELOPMENT OF THE VALLES
CALDERA

G. J. Langhorst Jun. 1980 16 p refs (LA-8398-MS) Avail: NTIS HC A02/MF A01

A preliminary evaluation is presented of possible and probable problems that may be associated with hydrothermal development of the Valles Caldera known geothermal resource area (KGRA), with specific reference to surface waters. Because of the history of geothermal development and its associated environmental impacts, this preliminary evaluation indicates the Valles Caldera KGRA will be subject to these concerns. Although the exact

nature and size of any problem that may occur is not predictable, the baseline data accumulated so far have delineated existing conditions in the streams of the Valles Caldera KGRA. Continued monitoring will be necessary with the development of geothermal resources. Further studies are also needed to establish guidelines for geothermal effluents and emissions.

N80-33972# Acurex Corp., Mountain View, Calif.
AIR POLLUTION CONTROL DEVICE CONFIGURATIONS
Final Consultant Report
Mar. 1980 48 p. refs

(PB80-193253; CAEC-59; CAEC-300-80-003) Avail: NTIS HC A03/MF A01 CSCL 13B

An analysis of data air pollutant abatement schemes for possible use on coal-fired electric generating plants is presented. Emphasis is placed on the effects of the arrangement of the control components, namely the baghouse, selective catalytic reduction and flue gas desulfurization units. Three basic configurations were identified as workable arrangements. The configurations were analyzed with respect to their capital, operating and maintenance cost impacts, reliability implications, and overall system removal efficiencies. Since there is no actual experience reported for these configurations with coal fired boilers, reliability and overall efficiency estimates were described qualitatively.

GR/

N80-33973# Acurex Corp., Mountain View, Calif.
ASSESSMENT OF H2S CONTROL TECHNOLOGIES FOR
GEOTHERMAL POWER PLANTS Final Consultant Report
Feb. 1980 123 p refs
(PB80-193709; CAEC-57; AEC-300-80-004) Avail: NTIS
HC A06/MF A01 CSCL 13B

Several technologies for controlling hydrogen sulfide (H2S) emissions from power plants are examined. The Hydrogen Peroxide Combination System, Stretford System, and possibly EIC or Coury upstream controls appear capable of compliance with the emission limitations of 100 grams per hour per gross megawatt in 1980 at the Geysers Dry stream field in Northern California. Potential controls for stacking are: (1) upstream abatement, (2) automated well operation, (3) computerized well-field operation (as of PG&E's Geysers Unit No. 15) and (4) further steamfield interconnection (cross-overs). Controls for liquid geothermal resources are largely in developmental or theoretical stages and greater efforts are needed to insure resource development with minimal environmental consequences.

N80-33980# Radian Corp., Austin, Tex.
STACK GAS REHEAT EVALUATION Final Report, Jun.
1977 - Feb. 1980
W. R. Menzies, C. A. Muela, and G. P. Behrens Mar. 1980

315 p refs

(Contract EPA-68-02-2642)

(PB80-196850: EPA-600/7-80-051) Avail NTIS HC A14/MF A01 CSCL 13B

Results of technical and economic evaluations of stack gas reheat (SGR) following wet flue gas desulfurization (FGD) for coal fired power plants are given. The evaluations were based on information from literature and a survey of PGD users, vendors, and architect/engineer firms. SGR processes and their features and their commercial operating experience are summarized. It addresses benefits and energy requirements associated with SGR, and describes a developed method for estimating reheat costs. SGR can protect equipment downstream of a wet scrubber from corrosion, reduce the potential for acid rainout near the plant stack, preclude visible stack plumes, and reduce ground level pollutant concentrations by increasing plume buoyancy.

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Includes solar collectors, solar cells, solar heating and cooling systems, and solar generators.

A80-45119 A proposed slotted mask for direct deposition of metal contact pattern on MIS solar cells. H. B. Nguyen (Miami, University, Coral Gables, Fla.). *IEEE Transactions on Electron Devices*, vol. ED-27, July 1980, p. 1303, 1304.

It is proposed that by using anisotropic etching of (100) silicon wafers, slots of very fine width (5-10 microns) can be formed. The slotted wafer is then used as a metallization mask through which a metal grid contact pattern can be directly deposited on top of solar cells, eliminating the photolithographic step.

(Author)

A80-45121 A multiple p-n junction structure obtained from as-grown Czochralski silicon crystals by heat treatment - Application to solar cells. J. Y. Chi, H. C. Gatos, and B. Y. Mao (MIT, Cambridge, Mass.). *IEEE Transactions on Electron Devices*, vol. ED-27, July 1980, p. 1306-1309. 11 refs. Research supported by the IBM Corp. and NASA.

Multiple p-n junctions have been prepared in as-grown Czochral-ski p-type silicon through overcompensation near the oxygen periodic concentration maxima by oxygen thermal donors generated during heat treatment at 450 C. Application of the multiple p-n-junction configuration to photovoltaic energy conversion has been investigated. A new solar-cell structure based on multiple p-n-junctions was developed. Theoretical analysis showed that a significant increase in collection efficiency over the conventional solar cells can be achieved. (Author)

A80-45299 Working fluids for solar, Rankine-cycle cooling systems. E. Wali. *Energy* (UK), vol. 5, July 1980, p. 631-639. 48 refs. Research supported by the University of Petroleum and Minerals.

Data are presented on the selection of appropriate working fluids suitable for solar cooling of buildings. Safety operation, system reliability, fluid thermal stability, pressure drop, heat transfer rates, and maximum allowable heat flux have been investigated for halogenated and fluorinated compounds in several prototype developments that are presently under construction. The results indicate that refrigerant R-113, followed by fluorinert fluid FC-88, are potential candidate working fluids for this type of application.

(Author)

A80-45311 A review of collector and energy storage technology for intermediate temperature applications. C. Wyman, J. Castle, and F. Kreith (Solar Energy Research Institute, Golden, Colo.). Solar Energy, vol. 24, no. 6, 1980, p. 517-540. 67 refs. Contract No. EG-77-C-01-4042.

The technology and thermal performance of intermediate temperature solar collectors is summarized and the status of thermal and thermo-chemical storage methods is reviewed. It is concluded that collector technology is commercially available to achieve delivery temperatures up to 350 F at averaged yearly efficiencies better than 30 per cent in good solar climates and that linear parabolic, single-axis tracking troughs are the best types of collectors currently available for intermediate temperature applications. On the other hand, energy storage options commercially available today are generally limited to sensible heat systems, which are bulky and expensive for long-term storage. More research is necessary to develop new storage concepts such as intermediate temperature chemical heat pumps based on reversible reactions, suitable for intermediate temperature solar systems with significant storage capability. (Author)

A80-45312 A packed bed dehumidifier/regenerator for solar air conditioning with liquid desiccants. H. M. Factor and G.

Grossman (Technion - Israel Institute of Technology, Haifa, Israel). Solar Energy, vol. 24, no. 6, 1980, p. 541-550. 30 refs. Research supported by the Israel Ministry of Commerce and Industry and Ministry of Energy and Infrastructure,

A packed column air-liquid contactor has been studied in application to air dehumidification and regeneration in solar air conditioning with liquid desiccants. A theoretical model has been developed to predict the performance of the device under various operating conditions. Computer simulations based on the model are presented which indicate the practical range of air to liquid flux ratios and associated changes in air humidity and desiccant concentration. An experimental apparatus has been constructed and experiments performed with Monoethylene Glycol (MEG) and Lithium Bromide as desiccants. MEG experiments have yielded inaccurate results and have pointed out some practical problems associated with the use of Glycols. LiBr experiments show very good agreement with the theoretical model. Preheating of the air is shown to greatly enhance desiccant regeneration. The packed column yields good results as a dehumidifier/regenerator, provided pressure drop can be reduced with the use of suitable packing.

A80-45313 A scheme for large scale desalination of sea water by solar energy. A. K. Rajvanshi (Florida, University, Gainesville, Fla.). Solar Energy, vol. 24, no. 6, 1980, p. 551-560. 16 refs.

A scheme is proposed to desalinate sea water using solar energy for the Thar Desert of India. The scheme has been designed to produce about 5.25 x 10 to the 7 cu m/yr (13860 MG/yr) of fresh water with 11.52 sq. km (4.5 sq miles) of collector area. The solar collectors are rectangular concrete tubes, half buried in the ground, through which sea water flows and is heated by solar energy. The heated sea water is then flash evaporated in a multi-stage flash evaporator (MSF) unit to yield fresh water. Pumping of the sea water to the site and through the MSF unit is powered by 415 wind turbines each of 200 kW capacity. Economic analysis of the scheme shows that it compares favorably with the existing fossil fuel fired desalination plants of the equivalent capacity. (Author)

A80-45314 Structures, reduction potentials and absorption maxima of synthetic dyes of interest in photochemical solar-energy storage studies. M. S. Chan and J. R. Bolton (Western Ontario, University, London, Canada). Solar Energy, vol. 24, no. 6, 1980, p. 561-574. 70 refs. Research supported by the Natural Sciences and Engineering Research Council of Canada.

The photochemical redox behavior of synthetic dyes is governed by their excitation energies and ground-state redox potentials. The structures, reduction potentials and absorption maxima of 66 water-soluble synthetic dyes have been tabulated in 5 classes, namely, acridines, phenazines, oxazines, thiazines and xanthenes. The relevant references for certain other dyes of current interest to solar energy research are also included. Examples are given of how this table can be used. Solar scientists working with dye-sensitized systems such as photogalvanic cells, pigmented semicondcutors or photochemical production of hydrogen gas should find this compilation useful. (Author)

A80-45316 Investigation of nitrate salts for solar latent heat storage. M. Kamimoto, T. Tanaka, T. Tani, and T. Horigome (Ministry of International Trade and Industry, Electrotechnical Laboratory, Sakura, Ibaraki, Japan). Solar Energy, vol. 24, no. 6, 1980, p. 581-587. 13 refs.

The properties of heat transfer in the discharging of a model solar latent heat storage unit based on various nitrate salts and salt mixtures are investigated. A shell-and-tube-type passive heat exchanger containing NaNO3 or eutectic or off-eutectic mixtures of NaNO3 with KNO3 and Ca(NO3)2 was heated to 40 K above the melting temperature of the salt, when air was made to flow through a heat transfer tube at a constant flow rate, and heat transfer material and air temperatures were monitored. Thermal conductivity and the apparent heat transfer coefficient are estimated from the heat extraction rate and temperature profiles, and it is found that

although the thermal conductivities of the materials are similar, the off-eutectic salts exhibit higher heat transfer coefficients. Temperature distributions in the NaNO3-KNO3 mixtures are found to be in fairly good agreement with those predicted by numerical solutions of a one-dimensional finite difference equation, and with approximate analytical solutions. It is observed that the temperature of the heat transfer surface drops rapidly after the appearance of a solid phase, due to the low thermal conductivity of the salts, and means of avoiding this temperature drop are considered.

A.L.W.

A80-45317 Economic requirements for new materials for solar photovoltaic cells. R. Singh (Colorado State University, Fort Collins, Colo.) and J. D. Leslie (Waterloo, University, Waterloo, Ontario, Canada). Solar Energy, vol. 24, no. 6, 1980, p. 589-592. 24 refs. Research supported by the Natural Sciences and Engineering Research Council of Canada.

The economic requirements which must be considered when examining the possibility of new materials for large scale photovoltaic applications, are described. It is shown that on the basis of these economic requirements, most of the new photovoltaic materials proposed by Schoijet (1979) can be eliminated as serious candidates. In addition, it is shown that highly efficient MIS solar cells can be fabricated using cheap and abundant Al and Si. It is concluded that as a result, there is no need to replace metals in Schottky devices by complex compounds.

M.E.P.

A80-45318 Heat loss and storage functions for a thermal well. R. L. Nicholls and T. N. Child (Delaware, University, Newark, Del.). Solar Energy, vol. 24, no. 6, 1980, p. 593-595. 6 refs.

Steady state loss and storage functions for a closed-circuit thermal well are studied. The steady state heat loss from the well to a ground surface is obtained, and the earth heat storage is derived by applying the superposition principle for the insulated portion of the well and by integrating temperature at a point in the vicinity of the well over volume.

A80-45319 Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation. O. M. Williams (Australian National University, Canberra, Australia). Solar Energy, vol. 24, no. 6, 1980, p. 597-600.

Heat transfer in solar absorber tubes heated nonuniformly by solar radiation is analyzed by use of a model in which the competing transfer modes of circumferential conduction and radial convection to the working fluid are treated separately. An integral formula in which the heat transfer characteristics are represented by two infinite ladder networks proceeding in opposite directions is derived analytically, enabling the circumferential temperature to be determined by standard numerical integration given the profile of the absorbed solar radiation. The formula is then used for the evaluation of temperature profiles in a row of heat absorption tubes exposed to directed solar radiation, as in the case of a cavity absorber operated at the focus of a tracking paraboloidal dish. A heat transfer formula allowing the maximum wall temperature difference to be evaluated using graphically determined values of the circumferential temperature difference profile and the effective circumferential angle is presented, which would facilitate the design of solar absorber tubes.

A80-45320 Heat exchanger effectiveness for solar collectors. W. F. Phillips (Utah State University of Agriculture and Applied Science, Logan, Utah). *Solar Energy*, vol. 24, no. 6, 1980, p. 601, 602. 9 refs.

The task of defining a heat exchanger effectiveness for a solar collector is addressed as well as that of expressing the collector effectiveness in terms of the usual dimensionless heat exchanger variables. It is shown that there is an inconsistency in the accepted procedure for analyzing heat exchangers which are designed to utilize solar energy, as compared to the accepted procedure for analyzing all other heat exchangers. It is noted that the inconsistency could be resolved by describing the performance of all heat exchangers in

terms of the same dimensionless parameter, either the heat exchanger effectiveness or the heat removal factor. J.P.B.

A80-45459 The sun-mill - A version of dunking-bird as an energy convertor of sun's radiation. K. Ikuta and S. Fujiwaka (Nagoya University, Nagoya, Japan). *Japanese Journal of Applied Physics*, vol. 19, June 1980, p. 1173-1176.

A new type of solar-powered heat engine with the help of gravitation is considered and discussed. The engine consists of an S-shaped vessel in which a working liquid and gas are contained. By the help of a shade and the axis of the vessel the center of gravity of the vessel moves up to the axis when the sun's radiation heats the working gas in the lower side of the vessel. As soon as the center of gravity climbs to the position of the axis the vessel rotates about its axis by the force of gravity. As long as the sun's radiation heats the lower side of the S-shaped vessel the engine continues to rotate. This type of solar-powered heat engine is called 'the sun mill'. Experimental results on the engine are given. (Author)

A80-45477 Autonomous solar-electric systems (Autonome solarelektrische Systeme). H. K. Köthe (Varta Batterie AG, Kelkheim, West Germany). *Elektronik*, vol. 29, Aug. 7, 1980, p. 38-43. 14 refs. In German.

The conditions regarding the autonomy of solar-electric systems are examined, noting that they can be fulfilled given a certain consumption and availability of solar energy, by appropriate design of the solar generator and the energy store. Attention is given to the graphic 'basis-system technique' which has been developed for the solution of this design task. The use of the technique is described and useful application information is derived from studying the peak power, the system power, and the mean consumer power of the system.

M.E.P.

A80-45504 Photoelectrochemical conversion using reaction-centre electrodes. A. F. Janzen (Photochemical Research Associates, Inc., London, Ontario, Canada) and M. Seibert (Solar Energy Research Institute, Golden, Colo.). *Nature*, vol. 286, Aug. 7, 1980, p. 584, 585. 18 refs. Contract No. EG-77-C-01-4042.

The production of photovoltages and photocurrents by a bacterial photosynthetic reaction center coupled to an SnO2 electrode is reported. Reaction centers isolated from membranes of the purple, nonsulfur photosynthetic bacterium Rhodopseudomonas sphaeroides R-26 were transferred to working electrode surfaces and photoeffects were monitored in the external circuit of a photoelectrochemical cell consisting of the working electrode, a platinized platinum or SnO2 counter electrode and a 0.1 M Na2SO4 and 5 M hydroquinone in water or Tricine buffer electrolyte. Small opencircuit photovoltages and short-circuit photocurrents were observed for platinized platinum electrodes coated with a thin film of reaction centers both before and after autoclaving, indicating that biologically active electron transfer is not involved. Reaction-center electrodes made using SnO2-coated glass were observed to generate photovoltages up to 70 mV and photocurrents of 0.3 microamp/sq cm. In addition, the action spectrum of the photocurrent in the external circuit was found to correspond to the absorbance spectra of reaction-center film and solution. It is concluded that charge separation generated across the reaction-center molecule as a result of the primary photochemistry of photosynthesis can be coupled directly to semiconductor electrodes and used to generate photoeffects in an external circuit. (Author)

A80-45662 # Production of photovoltaic devices. R. McGinnis (Motorola, Inc., Phoenix, Ariz.). (American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, Calif., Mar. 12-15, 1979, Paper 79-SOL-8.) ASME, Transactions, Journal of Engineering for Power, vol. 102, July 1980, p. 513-517. 5 refs.

This paper will provide a broad overview of present and future activities important for the production of Photovoltaic modules. First, the current methods for production will be reviewed, then a

study of the techniques for further development will lead to an attempt to describe the factory of the future for Photovoltaic device production. The paper will look at the issues and technologies for the conversion from high purity quartz to silicon substrates and will then analyze processes from substrates to finished solar cells, and finish by reviewing the concepts for the manufacturing of the Photovoltaic modules.

(Author)

A80-45722 \* # Spectral effects on direct-insolation absorptance of five collector coatings. G. B. Hotchkiss (Texas Instruments, Inc., Dallas, Tex.), F. F. Simon (NASA, Lewis Research Center, Cleveland, Ohio), and L. C. Burmeister (Kansas, University, Lawrence, Kan.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 6-8, 1979, ASME Paper 79-HT-18. 7 p. 16 refs. Members, \$1.50; nonmembers, \$3.00. Grant No. NsG-3087.

Absorptances for direct insolation of black chrome, black nickel, copper oxide, and two black zinc conversion selective coatings were calculated for a number of typical solar spectrums. Measured spectral reflectances were used while the effects of atmospheric ozone density, turbidity, and air mass were incorporated in calculated direct solar spectrums. Absorptance variation for direct insolation was found to be of the order of 1 percent for a typical range of clear-sky atmospheric conditions. (Author)

A80-45728 # Performance of an inlet manifold for a stratified storage tank. H. N. Gari, R. I. Loehrke, and J. C. Holzer (Colorado State University, Fort Collins, Colo.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 6-8, 1979, ASME Paper 79-HT-67. 9 p. 6 refs. Members, \$1.50; nonmembers, \$3.00. Contracts No. NG8305-76-C-0036; No. EG-77-S-4523-A000.

The operation of an inlet manifold for enhancing thermal stratification in a liquid thermal storage tank is described. The vertical, porous manifold is designed to remove the momentum of the incoming fluid and inhibit mixing while allowing buoyancy forces to position the fluid at the appropriate level in the tank, Equations which model the performance of this manifold are derived and solved for several typical sets of operating conditions. These equations yield predictions for the vertical distribution of the incoming flow within the storage tank for given inlet conditions, tank temperature profile and manifold characteristics. A manifold was designed and constructed for operation in a simulated solar heating system. The vertical pressure drop and wall permeability characteristics of this manifold were measured and used as input for the analytical model. (Author)

A80-46228 # Closed-cycle helium gas turbine for solar tower power plant (Turbines à gaz à circuit fermé d'hélium pour centrales solaires à tour). P. Duban (ONERA, Division Adjoint des Turbomachines, Châtillon-sous-Bagneux, Hauts-de-Seine, France). La Recherche Aérospatiale, Mar.-Apr. 1980, p. 109-122. In French. Research supported by the Délégation Générale à la Recherche Scientifique et Technique. (ONERA, TP no. 1980-28)

Thermodynamic conversion of solar energy through a process avoiding any long-term thermal storage can be considered a realistic objective for nations able to use other permanent energy sources. Even so, the building and maintenance of a solar tower power plant with its heliostat field require very large investments of primary energy. High thermal efficiency must be achieved to yield acceptable energetic returns, which in turn require an extensive input of advanced technical know-how. Closed-cycle helium gas turbines with an atmospheric cold heat source, currently under development for VHT nuclear power plants, meet the required criteria. In the 10 MW-el range, and a turbine inlet temperature of 900 C, the thermal efficiency of a complex gas turbine, including cooling between low-pressure and high pressure compressors and reheating between low-pressure and high pressure turbine and regenerative heat ex-

changer, lies between .41 and .43. This efficiency is constant in time and is sustained even at off-design operation; it is equivalent to the efficiency achieved by a thermal power plant, which allows running the solar plant with an auxiliary fossil fuel combustor. (Author)

A80-46251 The spectral response of CdS:Cu/x/S solar cells formed by dry barrier techniques. A. N. Casperd and R. Hill (Newcastle-upon-Tyne, Polytechnic, Newcastle-upon-Tyne, England). Solar Cells, vol. 1, Aug. 1980, p. 347-355. 17 refs.

The response to monochromatic radiation over the wavelength range 0.4-1.0 micron was measured for CdS:Cu(x)S solar cells dry formed under various conditions. It was found that the blue response was invariant with reaction time after the first few minutes whilst the red response increased with reaction time up to an optimum of about 15 to 20 min. The etching of the CdS prior to junction formation was shown to give a poor red response which decreased with increasing etch time. Junctions formed on identical CdS layers using wet chemical replacement techniques had the usual spectral response characteristics of such cells and it was shown that dry-formed cells have a better match to the air mass 1 spectrum than Clevite-type cells. (Author)

A80-46253 Solar energy conversion using CdSe photoelectrochemical cells with low cost substrates. S. Chandra (Banaras Hindu University, Varanasi, India), R. K. Pandey, and R. C. Agrawal (Ravishankar University, Raipur, India). Solar Cells, vol. 1, Aug. 1980, p. 367-370. 6 refs.

Photoelectrochemical cells using electrocodeposited CdSe films on low cost substrates (stainless steel and graphite) were studied. The usefulness of graphite as a counterelectrode in place of platinum was demonstrated. Results are reported for three cell configurations: stainless steel/CdSe//electrolyte//Pt; stainless steel/CdSe//electrolyte//Pt. (Author)

A80-46256 A solar thermophotovoltaic converter. F. Demichelis and E. Minetti-Mezzetti (Torino, Politecnico, Turin, Italy). Solar Cells, vol. 1, Aug. 1980, p. 395-403. 10 refs. Research supported by Fiat S.p.A.

A model of a thermophotovoltaic (TPV) converter is presented. Sunlight was focused by an optical system into a spherical cavity made of tungsten or of ytterbium oxide, thereby heating the cavity. The spectral region of the incandescent radiation emitted by the cavity in the range 0.6-1.1 microns (corresponding to the maximum efficiency of silicon cells) was directed onto a distribution of cells facing the radiator. The part of the spectrum not in the range 0.6-1.1 microns was sent back to the radiator and recycled. Conversion efficiencies of about 24% are possible in a TPV converter operating with a 2000 K radiator. (Author)

A80-46257 MIS and SIS solar cells on polycrystalline silicon. G. Cheek (Solar Energy Research Institute, Golden, Colo.) and R. Mertens (Leuven, Katholieke Universiteit, Heverle, Belgium). Solar Cells, vol. 1, Aug. 1980, p. 405-420. 39 refs. Research supported by the Belgian National Science Foundation.

MIS- and SIS-structured solar cells are receiving much attention in the photovoltaic community. Apparently these cells could be a viable alternative to thermally diffused p-n junctions for use on thin film polycrystalline silicon substrates. In this paper MIS- and SIS-structured solar cells and the possible advantages of these structures for use with thin film polycrystalline silicon are reviewed. The results of efficiency calculations are presented. The lifetime stability and fabrication techniques amenable to large-scale production are also considered. Finally, the relative acvantages and disadvantages of these cells and the results obtained are presented.

(Author)

A80-46258 Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states. A. K. Ghosh, T. Feng, and H. P. Maruska (Exxon Research and Engineering Co., Linden, N.J.). Solar Cells, vol. 1, Aug. 1980, p. 421-429. 18 refs. Contract No. DE-AC03-89ET-23047.

The theory of polycrystalline solar cells is extended by introducing effects due to the reduction in grain boundary states. The calculations show that a large improvement in efficiency can be attained either by increasing the grain size or by passivating the grain boundary states to reduce the number of recombination centers.

(Author)

A80-46259 Selenium heterostructure solar cells. R. F. Shaw and A. K. Ghosh (Exxon Research and Engineering Co., Linden, N.J.). Solar Cells, vol. 1, Aug. 1980, p. 431-433.

Selenium solar cells with an exposed area efficiency of about 3.72% and an engineering efficiency of 3.04% are reported. Elemental selenium is fused and crystallized on a semipolished iron substrate previously coated with tellurium. CdSe and CdO layers are then formed in one process by reactively sputtering cadmium metal in air at 1.3 Pa for 18 min at an RF power density of 0.5 W/sq cm. A typical photovoltaic cell produced by this technique has an open-circuit voltage of 0.74, a short-circuit current of 8 mA/sq cm, and a fill factor of 0.49 with a sunlight irradiance of 95 mW/sq cm. It is estimated that engineering efficiencies of better than 10% can be achieved with these selenium devices.

A80-46349 Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors. C. H. Liu and E. M. Sparrow (Minnesota, University, Minneapolis, Minn.). International Journal of Heat and Mass Transfer, vol. 23, Aug. 1980, p. 1137-1146. 7 refs.

An analysis is made for simultaneously developing laminar velocity and temperature fields in a parallel plate channel in which convective and radiative heat transfer interact. One wall of the channel is externally heated and the other is externally insulated; air is the heat transfer fluid. These conditions are similar to those in an air-operated flat-plate solar collector. The results show that the radiant interchange causes the task of convective heating of the fluid to be shared between the two walls, with as much as 40% of the convective transfer taking place at the externally adiabatic wall. This can give rise to a significant reduction of the temperature of the directly heated wall which, for a solar collector, tends to improve its efficiency. The Nusselt numbers in the presence of radiation are higher than those for pure forced convection. (Author)

A80-46382 # The potential global market in 2025 for Satellite Solar Power Stations. A. Dupas and M. Claverie (CNRS, Paris, France). In: Space manufacturing III; Proceedings of the Fourth Conference, Princeton, N.J., May 14-17, 1979.

New York, American Institute of Aeronautics and

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 71-76. 25 refs.

Starting from the hypothesis of moderate growth for energy demand through 2000/2025, the market of Large Electrical Power Plants (LEPP) in the range 24-40 TWh/yr suited for base-load electrical needs was computed. A numerical model predicting the future demands for centralized and decentralized electrical energy according to geographical position was developed. The inputs to this model are: the geographical distribution of population at the present time, the energy demand growth in the different world regions, the part of energy consumption used for electricity generation in each world region. The model leads to a world market for LEPP in 2020/2025 of 752/942 plants, which could be provided alternatively by conventional thermal plants, breeder nuclear reactors, fusion reactors or SSPS (Satellite Solar Power Station) among the centralized concepts.

A80-46386 \* # Scaling and the start-up phase of space industrialization. D. R. Criswell (Lunar and Planetary Institute, Houston, Tex.). In: Space manufacturing III; Proceedings of the Fourth Conference, Princeton, N.J., May 14-17, 1979.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 223-233, 30 refs. Contract No. NSR-09-051-001.

By terrestrial standards very little mass is needed to construct the space portion of a 10,000 megawatt (10 GW) power system. Use of lunar materials makes it reasonable to consider alternatives to silicon solar cells for conversion of sunlight to electricity and thereby avoid present major problems associated with solar cell production. Machinery needed on the moon to excavate lunar materials and deliver them to a transport system, to beneficiate lunar materials, to produce glasses and ceramics from lunar materials and to chemically process lunar materials into their major oxides and elements are minor mass fractions of the total mass of equipment needed in space to produce an SPS. In addition the processing equipment can throughput several hundred times their own mass each year with very little requirement for makeup mass from earth. (Author)

A80-46387 # The benefits of solar power satellites. P. E. Glaser (Arthur D. Little, Inc., Cambridge, Mass.). In: Space manufacturing III; Proceedings of the Fourth Conference, Princeton, N.J., May 14-17, 1979. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 235-242; Discussion, p. 241, 243. 20 refs.

The development of solar power satellites (SPS) is discussed in light of the benefits the conversion of solar power in space for use on earth would have for terrestrial energy supplies. The SPS reference system adopted for the purposes of economic and environmental assessment studies is outlined, and technological options available for system components are examined. The economics and organizational aspects of SPS are considered, with attention given to cost estimates, financing, and political and social consequences. Results of studies indicating minimal environmental impact of SPS are indicated, although it is noted that especially as regards the biological effects of microwave exposure much work remains to be done.

A.L.W.

A80-46452 \* Reduction of intensity variations on the absorbers of ideal flux concentrators. P. Greenman (Chicago, University, Chicago, III.). *Applied Optics*, vol. 19, Aug. 15, 1980, p. 2812-2821. 22 refs. Contracts No. ER-78-S-02-4657; No. JPL-954563.

Large nonuniformities occur in the instantaneous distribution of flux on the absorber of an ideal light concentrator when it is illuminated by a point source such as the sun. These nonuniformities may be reduced by texturing the reflecting surface with small distortions. Such distortions will also be effective if used in the primary reflector of a two-stage concentrator. Data on a model compound parabolic concentrator are presented. The suitability of such concentrators for use by spacecraft is mentioned.

T.M.

A80-46475 Conduction in sputtered a-Si-H Schottky-barrier solar cells. M. J. Thompson, M. M. Alkaisi, and J. Allison (Sheffield, University, Sheffield, England). *IEE Proceedings, Part 1-Solid-State and Electron Devices*, vol. 127, pt. I, no. 4, Aug. 1980, p. 212-217. 18 refs.

This paper describes the conduction mechanisms in RF-sputtered Schottky-barrier solar cells incorporating hydrogenated amorphous Si (a-Si-H). The illumination and temperature dependence of the open-circuit voltage and the short-circuit current of the cells are discussed. The properties of the cells containing optimum and nonoptimum a-Si-H and various Schottky metals are contrasted. The temperature dependence of the forward characteristics of the cells is also examined. Three different conduction mechanisms in the Schottky-barrier cells are identified and described. (Author)

A80-46496 High-efficiency InP homojunction solar cells. G. W. Turner, J. C. C. Fan, and J. J. Hsieh (MIT, Lexington, Mass.). Applied Physics Letters, vol. 37, Aug. 15, 1980, p. 400-402, 14 refs. USAF-supported research.

Conversion efficiencies up to 15% (AM1) have been obtained for antireflection-coated InP homojunction solar cells, the highest efficiency values reported for InP cells of any type. The cells were fabricated on n(+)/p/p(+) structures formed by liquid phase expitaxy on single-crystal InP substrates. The cell photovoltaic characteristics are not very sensitive to n(+) layer thickness, indicating that the surface recombination velocity is not as high as in homojunction

GaAs solar cells. The performance of various antireflection coatings (Author) has been investigated.

A80-46566 Generalization of the two-dimensional optical analysis of cylindrical concentrators. R. O. Nicolás and J. C. Durán (Comisión Nacional de Energía Atómica, División Energía Solar, Buenos Aires, Argentina). Solar Energy, vol. 25, no. 1, 1980, p. 21-31. 8 refs. Research supported by the Argentine State Secretariat for Science and Technology.

The paper describes a two-dimensional optical analysis of cylindrical concentrators valid for any incidence angle of the solar rays. In contrast to previous two-dimensional studies, it takes into account the angle kappa defined by the solar rays and a plane perpendicular to the focal line, and variations of the image width as a function of kappa. An equation relating kappa to solar coordinates has been derived; the curves of kappa as a function of time for several dates and three orientations of the concentrator are presented. The analysis is applied to the cylindrical-parabolic concentrator and to the fixed-mirror solar concentrator, both with flat receivers. The local concentration factor and its mean value for different values of kappa are obtained; with these results and taking into account the useful range of kappa, criteria are given for selection of concentrator orientation and the receiver width.

A80-46567 Computer simulation of solar pond thermal behavior. J. R. Hull (Iowa State University of Science and Technology; U.S. Department of Energy, Ames Laboratory, Ames, Iowa). Solar Energy, vol. 25, no. 1, 1980, p. 33-40. 16 refs. Research supported by the Iowa State University of Science and Technology and U.S. Department of Energy.

A computer model of salt gradient solar pond thermal behavior has been developed and used to verify the validity of assuming constant salt solution physical parameters and long term averaging schemes for ambient temperature and insolation in previous solar pond analytical models. A theoretical limit for pond transparency is calculated which is significantly higher than that previously assumed. It is suggested that a transparent membrane be placed just below the air/water interface of solar ponds to maintain pond solution purity and approach the theoretical limit for transparency. A means of estimating the diffuse insolation input into a solar pond is given which utilizes sky color temperatures for different values of the clearness index. A single sky color temperature is calculated for each average clearness index value. (Author)

Oxide semiconductors in photoelectrochemical conversion of solar energy. D. E. Scaife (Commonwealth Scientific and Industrial Research Organization, Div. of Mineral Chemistry, Melbourne, Australia). Solar Energy, vol. 25, no. 1, 1980, p. 41-54, 49 refs.

The paper examines a wide range of oxides for use as anodes in photoelectrochemical cells for the conversion of solar energy into electrical power of hydrogen. The Schottky barrier model of the semiconductor-electrolyte interface is used; type (a) oxides, not containing partly filled d-levels, conform to a relationship between flat band potential and band gap; this essentially rules out the possibility of finding type (a) oxides with simultaneously small band gap and large negative flat band potential required for efficient operation in the unbiased photoelectrolysis of water. Incorporation of this relationship into the Schottky barrier formula for photocurrent makes possible the calculation of efficiencies of conversion for type (a) oxides; for power cells with redox operation, type (a) oxides are predicted to give 5-6% efficiency for a band-gap of 2.4 eV, with a redox couple of standard potential not less than 0.8.

Sizing procedure and economic optimization methodology for seasonal storage solar systems. M. S. Drew and R. B. G. Selvage (S-Matrix Enterprises, Ltd., Vancouver, British Columbia, Canada). Solar Energy, vol. 25, no. 1, 1980, p. 79-83. 13 refs.

The paper presents a method of sizing procedure and economic optimization methodology for seasonal water systems based on approximately sinusoidal tank temperature profile in seasonal water

systems. With this assumption, the matching of initial and final temperatures is enforced, so that correct combination of the other system parameters can be determined by solving a set of heat balance equations. The system parameters include the loads, the Collector area A, the water storage volume V, and the storage tank insulation. A sinusoidal expression is derived for the tank temperature; the solution for A and V giving an exact balance of heat over the year can be found by solving simultaneously the two equations describing the temperature change in the tank during the period when the temperature is rising and when it is falling. An expression for the period of heat gain is derived in terms of V, the water-densityspecific heat product, the summer minimum to maximum temperature increase, A, and the building heat loss coefficient.

A80-46571 Total and non-isotropic diffuse insolation on tilted surfaces. V. M. Puri, R. Jimenez, M. Menzer (Delaware, University, Newark, Del.), and F. A. Costello (Frederic A. Costello, Inc., Herndon, Va.). Solar Energy, vol. 25, no. 1, 1980, p. 85-90. 24

The paper extends the Liu and Jordan (1977) correlations between direct and diffuse insolation to predict instantaneous fluxes on surfaces in any orientation, and introduces a new procedure to allow for anisotropic as well as isotropic diffuse radiation. An expression is derived for total insolation on a horizontal surface, and a correlation equation is written for the ratio of the direct flux on a horizontal surface to the flux that would be incident on a horizontal surface outside the atmosphere. The successful predictions of the Threlkeld (1962), Morrison and Farber (1974), and data presented in this paper substantiate the proposed method of including the nonisotropic component of diffuse radiation in the estimation of total solar radiation. This model uses the total solar flux on a horizontal surface as the input parameter, making useful horizontal insolation data of many years from weather stations for solar system

Structure of amorphous silicon and silicon A80-46647 hydrides. T. A. Postol, C. M. Falco, R. T. Kampwirth, I. K. Schuller (Argonne National Laboratory, Argonne, III.), and W. B. Yelon (Missouri-Columbia, University, Columbia, Mo.). Physical Review Letters, vol. 45, Aug. 25, 1980, p. 648-652, 10 refs. Research supported by the U.S. Department of Energy.

Neutron scattering measurements have been made on pure, hydrogenated, and deuterated samples of amorphous silicon (a-Si) in the wave-vector range 0.007-8.75/A. Small-angle data indicate structures in the samples of average radius of gyration as large as 270 A. Large-angle data show that for the concentrations measured (14%), the structure of a-Si is not altered by the incorporation of large amounts of H or D. The silicon-hydrogen and silicon-deuterium (Author) partial structure factors have also been obtained.

A80-46688 # Prospects for using solar energy to power materials-science furnaces in space. U. Huth (ESA, Space Transport Systems Dept., Paris, France) and M. Bader (Dornier System GmbH, Friedrichshafen, West Germany). ESA Journal, vol. 4, no. 2, 1980, p. 147-158.

This paper considers the prospects for using direct solar energy for the operation of materials-science furnaces in space. The motivation for investigating this alternative - as opposed to the electrical resistance heating actually employed on the First Spacelab Payload: stems from the severe constraints imposed on the operation of the electrical furnaces from a power and energy point of view. The paper, based on the results of a study performed under contract to ESA by Dornier System GmbH, discusses the major elements of solar-furnace concepts that consist essentially of an energy collector, an energy-transfer system and the furnace itself. The fundamentals of a 'light concept' system and a 'heat concept' system are summarized. (Author)

A80-46694 Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Conference sponsored by the Commission of the European Communities. Edited by R. Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium) and W. Palz (Commission of the European Communities, Brussels, Belgium). Dordrecht, D. Reidel Publishing Co., 1979. 1228 p. In English and French. \$71.05.

The conference concentrated on fundamental studies, crystalline silicon materials, silicon cells, modules, and economic analyses. Other major subjects included amorphous silicon, compound semiconductor cells, space applications and testing, concentrators and concentrating systems, demonstration projects, and national programs. V.L.

A80-46695 New experimental evidence for minority carrier MIS diodes. N. G. Tarr and D. L. Pulfrey (British Columbia, University, Vancouver, Canada). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 58-64. 8 refs. Research supported by the National Research Council of Canada.

Measurements of short-circuit current density J(sc) and opencircuit photovoltage V(oc) have been made over a range of illumination levels at various temperatures for Al-SiO(x)-pSi MIS photodiodes. It is found that at high illumination levels the data satisfy the relation J(sc) = J(o)exp(qV(oc)/kT) where J(o) is a temperature-dependent constant. By examining the variation of J(o) with temperature it is conclusively demonstrated that the dark current in these diodes is dominated by minority carrier flow, confirming recent theoretical predictions. (Author)

A80-46696 The influence of grain size and dopant concentration on the electrical properties of polycrystalline silicon films. M. W. M. Graef, J. Bloem, L. J. Giling, J. R. Monkowski, and J. W. C. Maes (Nijmegen, Katholieke Universiteit, Nijmegen, Netherlands). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 65-74. 8 refs. Commission of the European Communities Grant No. 442-78-2-ESN.

Polycrystalline silicon layers with different mean crystallite size were grown onto various substrates via chemical vapor deposition. The conductivity and carrier concentration of these films was studied as a function of the doping concentration. The conclusion, drawn from these studies, is that in polycrystalline silicon the dopant is distributed homogeneously throughout the film. No apparent dopant segregation was found for phosphorus and boron concentrations between 10 to the 15th and 10 to the 19th atoms/sq cm. Thus, the electrical behavior is solely determined by electrical energy barriers at the grain boundaries. Measurements of the mobility and the temperature dependence of the conductivity lead to a quantitative model for the energy band structure at grain boundaries, viz., a homogeneous continuous distribution of interface states over the band gap. (Author)

A80-46697 Comprehensive explanation of efficiency limits in silicon solar cells. D. Redfield (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 75-81, 10 refs.

The large discrepancy between the best observed AM0 efficiency (15%) of silicon solar cells and predicted theoretical values (20-22%) is explained in a single comprehensive model based on Auger processes in heavily doped silicon. This single class of physical processes accounts for all four major types of limitations observed: the contributions of both the front and base regions to both the open-circuit voltage and the short-circuit current density. This explanation replaces various fragmented previous models and shows that observed limitations are inherent in the design of these cells and are not consequences of technological faults. (Author)

A80-46698 Technology and economics of starting materials for low-cost silicon solar cells. E. Sirtl (Heliotronic GmbH, Burghausen, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 84-97. 23 refs. Bundesministerium für Forschung und Technologie Contracts No. NT-0845; No. NT-0846.

The paper deals with large-scale bulk silicon preparation techniques. The variety of different potential or already investigated approaches are studied. Attention is given to (1) abundance of resources, (2) low-cost manufacturing, (3) impurity optimization, and (4) low-energy processing.

A80-46699 Progress on the Dow Corning process for solar-grade silicon. L. P. Hunt and V. D. Dosaj (Dow Corning Corp., Hemlock, Mich.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 98-105. 16 refs. Research supported by the U.S. Department of Energy and NASA.

The Dow Corning approach to increasing the resistivity of solar-grade silicon from about 0.04 ohm-cm (40 ppma B) to greater than 0.1 ohm-cm (10 ppma B) involves the use of high-purity raw materials carbothermically reduced in a specially designed electric arc furnace. Final purification occurs during Czochralski crystal growth of a polycrystalline ingot. This small-scale purification technology has resulted in silicon that has been fabricated into solar cells with a maximum AM1 conversion efficiency of 13.4%.

A80-46700 \* Low-cost, high-efficiency silicon by heat exchanger method and fixed abrasive slicing technique. C. P. Khattak and F. Schmid (Crystal Systems, Inc., Salem, Mass.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 106-113. 14 refs. Research supported by the U.S. Department of Energy and NASA.

The paper describes the heat exchanger method (HEM) for growing silicon crystals. The problem of ingot cracking was solved by using a graded structure silica crucible, and vacuum processing eliminated expensive high-purity argon. Solar cells fabricated from HEM silicon demonstrated conversion efficiencies up to 15% (AM1) at low cost, using square cross-section, single crystal silicon. A modified multiblade slurry machine was adapted for multiwire fixed abrasive slicing of silicon which uses a diamond attached to wires; this method provides a conversion ratio of 1.08 sq m of wafer per kg of silicon ingot, and produces wafers free of edge chipping with a surface damage of 3-5 microns.

A80-46701 Early assessment of the photovoltaic potentialities of RAD polysilicon sheets. C. Belouet, E. Fabre, S. Makram-Ebeid, N.-T. Phuoc, and C. Texier (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Reidel Publishing Co., 1979, p. 114-122. 13 refs. Research supported by the Commission of the European Communities.

This paper shows that AM1 conversion efficiencies of about 11 percent can be reasonably envisaged for RAD polycrystalline solar cells. The factors limiting the performances of the cells - planar faults, carbonaceous precipitates and layer/substrate interface - are discussed and the directions for further improvements are briefly outlined. (Author)

A80-46703 Low cost crystalline silicon. G. H. Schwuttke (IBM East Fishkill Laboratories, Hopewell Junction, N.Y.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 130-144. 9 refs.

Economically viable means of producing silicon sheets for low cost solar cells are discussed. Emphasis is given to the discussion of

three major crystal growth techniques: (1) Czochralski, (2) ribbon, and (3) casting. Economic and technological comparison indicates that crystals grown in ingot shape (Czochralski) can meet a price goal of \$2 per watt peak if semicontinuous crystal pulling can be implemented. Polysilicon at a price of \$10 per kg is required. A lower price goal for ingot technology requires improvements in ingot slicing techniques. Ribbon technology has the potential of approaching a price goal of \$1 per watt peak but it requires that sheets can be grown continuously directly from the melt at a width of 20 cm, 0.25 mm thick and at a rate of 7 cm/min. (Author)

A80-46704 Potential for improved silicon ribbon growth through thermal environment control. R. W. Gurtler, A. Baghdadi, R. N. Legge, and R. J. Ellis (Motorola, Inc., Solar Energy Dept., Phoenix, Ariz.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 145-152. 6 refs. Research supported by the U.S. Department of Energy; Contract No. JPL-954376.

The Ribbon-to-Ribbon (RTR) process for growth of silicon ribbon is described. This process involves the fabrication of a microcrystalline ribbon of silicon and subsequent grain size enhancement through a laser recrystallization process. The microribbon is obtained from a Thermal Expansion Shear Separation (TESS) process which allows a CVD layer of silicon to be separated from a temporary molybdenum substrate. Efforts to achieve increased solar cell efficiencies and higher area production rates have been problematical. Furnaces, which are necessary for thermal stress control, have been shown to contribute contamination to substrates resulting in degraded efficiencies. Recent results with a new furnace design indicate efficiencies in excess of 9% will be routine. Limitations to area throughput arise due to fundamental linear velocity limitations and width limitations necessary to prevent the occurrence of thermal buckling. Calculations are reported which show the influence of thermal profile on buckling tendencies, and a proposed electron beam technique is considered which promises high throughput with minimal buckling.

A80-46705 Ion implanted solar cells from EFG silicon ribbons. R. O. Bell, C. T. Ho, K. V. Ravi (Mobil Tyco Solar Energy Corp., Waltham, Mass.), J. C. Muller, P. Siffert (CNRS, Centre de Recherches Nucléaires de Strasbourg, Strasbourg, France), and F. V. Wald. In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 153-161. 6 refs.

In an initial investigation of ion implantation into EFG silicon ribbon using both conventional and glow discharge techniques, solar cell efficiencies between 9.5 and 10.6 percent were achieved without efforts to optimize almost any of the variable parameters in the solar cell fabrication sequence. These techniques can thus be considered as being quite useful for terrestrial solar cell fabrication, particularly if high implantation rate equipment becomes available. At present, it may be shown that in a laboratory scale glow discharge apparatus, implant rates of approximately 2 cm/min can be achieved on 2.5 cm wide ribbon in a continuous fashion. However, the laser pulse annealing process used in conjunction with this technique needs to be optimized. This is being accomplished by installing a laser with a higher power output and automatic means to cover the total cell surface reliably with laser pulses. (Author)

A80-46706 Experimental optimization of the efficiency of n/+/-p-p/+/ and p/+/-n-n/+/ silicon solar cells. J. Van Meerbergen, J. Nijs, F. D'Hoore, R. Mertens, and R. Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Co., 1979, p. 164-171. Research supported by the Nationaal Fonds voor Wetenschappelik Onderzoek; Commission of the European Communities Contract No. 153-77-9-ESB.

The use of doped oxides for processing two diffusions in back surface field (BSF), cells in one temperature step is discussed,.

Consideration is given to two types of BSF cells: p(+)-n-n(+) and n(+)-p-p(+). The efficiency of 14% has been obtained with non-polished grade II material by a process that can be automated. V.T.

A80-46707 A high volume process for silicon solar cells using solid diffusion sources. R. E. Thomas, G. C. Salter, and A. A. Armstrong (Carleton University, Ottawa, Canada). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 172-180. National Research Council of Canada Grant No. OSX-78-00062.

A solid source diffusion process for preparing diffused junction n(+)-p-p(+) or p(+)-n-n(+) silicon solar cells is reported. The process offers reduction in wafer handling and chemical processing, elimination of diffusion gases, and the potential for very large batch sizes.

V.T.

A80-46708 A new diffusion process for silicon solar cells. J. Michel and B. G. Martin (Laboratoires d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 181-188. 8 refs. Research supported by the Commissariat à l'Energie Solaire.

A new diffusion process able to lead to a very low-cost and highly automated silicon solar cell fabrication has been investigated. It consists of doping, with silicon dopants, transparent and conductive layers of indium tin oxide deposited by 'spray' onto the silicon, these layers not being removed after formation of the junction into the silicon by diffusion. Diffusion of phosphorus has not been achieved probably due to InP formation. Diffusion of boron leads to solar p(plus)/n cells having similar characteristics to those made with a classical diffusion.

A80-46709 Degradation effects in silicon Schottky barrier solar cells. J. A. Grimshaw and W. G. Townsend (Royal Military College of Science, Shrivenham, Wilts., England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 197-204.

Single crystal and polycrystalline silicon-thin oxide-aluminum Schottky barrier solar cells are investigated with reference to the long-term stability under prolonged illumination at room temperature. It is found that prolonged illumination induces continuous degradation of I/V characteristics. The efficiency of the cells is restored after holding them in the dark or after a 15 minute anneal at 90 C. It is suggested that the observed degradation is associated with atomic migrational processes stimulated by illumination, which probably involve the migration of oxygen between the interface layer and the cell exterior via the metal. Results also indicate that degradation effects could be eliminated by a suitable a.r. coating or encapsulant.

A80-46710 Advanced thin silicon solar cell with controlled optical absorptance. K.-D. Rasch, K. Roy, and K.-H. Tentscher (Telefunken AG, Heilbronn, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 205-212. Research supported by the Bundesministerium für Forschung und Technologie.

An advanced thin silicon solar cell with an optical back surface reflector (BSR) is discussed with reference to its design, metallurgical problems, optical absorptance, and the compatibility of electrical, mechanical, and optical requirements. The BSR cell has an operating temperature of more than 15 C lower than the conventional cell, and therefore has an improvement of more than 1% (absolute) in cell efficiency in space. This advantage of the BSR cell is not affected by radiation damage.

A80-46711 Effect of laser irradiation on the characteristics of implanted layers for silicon solar cells. F. Zignani, A. Desalvo (Bologna, Università, Bologna, Italy), R. Galloni, L. Pedulli, G. G. Bentini, M. Servidori, and F. Cembali (CNR, Laboratorio LAMEL, Bologna, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 213-221. 9 refs.

A80-46713 Progress in the field of terrestrial solar generators. R. Buhs, G. Nagel, and H. D. Wegmann (Telefunken AG, Wedel, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 236-242. 9 refs. Research supported by the Bundesministerium für Forschung und Technology.

Development activities in the fields of solar cells, interconnection techniques, encapsulation, and framing techniques are described. Consideration is given to the production of solar generator modules. Two alternatives to flat solar generators are outlined. V.T.

A80-46714 Study of sandwich type glass encapsulation. Y. Salles, J. Anguet, and A. Desombre (La Radiotechnique Compelec, Caen, Calvados, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 243-250. Commission of the European Communities Contract No. 107-76-ESF.

A study of application of sandwich glass technology to solar cell encapsulation is presented. A feasibility investigation was made by encapsulating thirty modules built of very high resistance glass into  $30 \times 30$  cm panels which were encapsulated with the sandwich glass process. It was then shown that this process is also suitable for models up to 0.5 sq m in size; the final design of the solar module is described, including its simplicity of assembly, industrial operations, and weather resistance. The module mechanical properties were determined, concluding that their mechanical strength and climatic resistance were satisfactory; the climatic resistance was superior to that of the standard silicon module.

A80-46715 A revised economic analysis of photovoltaic power modules. A. V. Whale and R. D. Wingrove (Ferranti Electronics, Ltd., Oldham, Lancs., England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Co., 1979, p. 251-259.

A method of cost analysis of photovoltaic power modules is presented. It is shown that the limit in photovoltaic cost reduction is set ultimately by mechanical and not semiconductor considerations. The affection of variations in various cost parameters on the final module cost is outlined.

A80-46716 The design of photovoltaic systems for residential applications in the United States. G. J. Jones (Sandia Laboratories, Albuquerque, N. Mex.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 260-267. Research supported by the U.S. Department of Energy.

Subsystem options, operational modes, and economic scenarios of the future applications of photovoltaic systems are considered. Results indicate that all-electric systems using high-efficiency heat pump technology appear viable at nearly all sites. Photovoltaic only systems operating interactively with the utility grid appear to be the first choice.

V.T.

A80-46717 Optimization studies of materials in hydrogenated amorphous silicon solar cells. J. J. Hanak, V. Korsun, and J. P. Pellicane (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979,

Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 270-277. 14 refs.

The paper presents an optimization study of the multilayer p(+)-i-n(+) structure of a hydrogenated amorphous silicon (a-Si:H) solar cell. The technique used in the study is based on the synthesis of samples having one or two independent parameters graded over the surface of a planar substrate.

V.T.

A80-46719 Evaluation of multijunction structures using amorphous Si-Ge alloys. Y. Marfaing (CNRS, Laboratoire de Physique du Solide, Meudon, Hauts-de-Seine, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 287-294. 12 refs.

A technique for increasing the efficiency of a Si based solar cells is described, which utilizes a multijunction structure with the related a Si-Ge alloys. The conversion efficiencies calculated for two and three-junction structures are in the range of 12-21%.

A80-46720 Schottky barriers on sputtered hydrogenated amorphous silicon - Photovoltaic properties and capacitance-voltage characteristics. L. Vieux-Rochaz, A. Chenevas-Paule (Commissariat à l'Energie Atomique, Laboratoire d'Electronique et de Technologie de l'Informatique, Grenoble, France), D. Jousse, and P. Viktorovitch (Ecole Nationale Supérieure d'Electronique et Radio-Electricité, Grenoble, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 295-302. 9 refs. Research supported by the Commission of the European Communities.

A80-46721 Contact formation, scaling and optimisation of large-area R.F. sputtered a-Si Schottky barrier solar-cells. M. J. Thompson, M. M. Alkaisi, and J. Allison (Sheffield, University, Sheffield, England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 303-311. 5 refs.

It is now well established that the inclusion of hydrogen in a Si is responsible for the large reduction in the density of states observed. This paper is concerned with the effect of hydrogenation of RF sputtered a-Si as used in Schottky barrier solar cells. The temperature dependence of the I-V characteristics is related to the bulk properties of the a-Si prepared in plasmas containing different hydrogen partial pressures. The optimum barrier performance is compared with that for samples prepared in hydrogen above and below the critical hydrogen pressure. Localized state conduction appears responsible for the reduction in Schottky barrier performance. Apparent changes in majority carrier type occur in samples containing high hydrogen concentrations. Devices are described which consist of junctions between a-Si layers containing different quantities of hydrogen. Improved solar-cell performance is obtained when such layers are incorporated. Scaling cells to large areas produces no special problems. (Author)

A80-46722 The stability of amorphous silicon Schottky-barrier solar cells. D. E. Carlson and C. W. Magee (RCA Laboratories, Princeton, N.J.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 312-319. 7 refs. Research supported by RCA; Contract No. ET-78-C-03-2219.

The electronic properties of hydrogenated amorphous silicon (a-Si:H) are adversely affected by ion bombardment during the glow discharge deposition of the material. Electron-beam evaporation of Pt Schottky barriers creates defects in a-Si:H due to electron bombardment; the X-rays generated during evaporation do not affect the photovoltaic properties. Exposure of Pt Schottky-barrier and MIS cells to water vapor causes a gradual degradation apparently due

to the injection of OH(-) ions into the space charge region. Water vapor also causes a short-term degradation in MIS cells that can be reversed by a brief heat treatment at 200 C. Encapsulation of both Pt Schottky-barrier and MIS cells is necessary for long-term stability.

(Author

A80-46724 Interface recombination and junction field studies in the Cu2S-CdS solar cell. L. M. Kilgren (Delaware, University, Newark, Del.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 344-351. 8 refs.

A80-46725 EBIC and capacitance measurements on Cu2S-CdS solar cells - Stability problems. F. Pfisterer, H. W. Schock, and G. H. Hewig (Stuttgart, Universität, Stuttgart, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 352-360. 14 refs. Bundesministerium für Forschung und Technologie Contract No. ET-4045.

A80-46726 Optimal material properties for CdS/Cu2S solar cells. A. Rothwarf (Delaware, University, Newark, Del.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 370-378. 20 refs. Contract No. EG-77-C-03-1576.

A heterojunction model accounting for many of the properties of a CdS/Cu2S solar cell is reviewed. Emphasis is placed on the role of the material properties of the Cu2S and CdS layers. The combined experimental and theoretical results indicate that the donor density N(D) in CdS and the acceptor density N(A) in Cu2S are the crucial material properties.

A80-46727 Thin film /CdZn/S for solar cells. T. L. Hench and R. B. Hall (Delaware, University, Newark, Del.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 379-386. 10 refs.

The paper reports a method of (CdZn)S film growth which achieves the necessary spatial uniformity and allows for the independent control of composition and resistivity. The performance of photovoltaic devices made from these films are also presented.

VΤ

Á80-46728 Progress in the development of the thin film MIS solar cell based on CdSe. D. Bonnet (Battelle-Institut, Frankfurtam-Main, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 387-395. Research sponsored by the Commission of the European Communities and Bundesministerium für Forschung und Technologie.

A80-46729 An S.E.M. study of thin films made by spray pyrolysis. C. M. Lampkin (Photon Power, Inc., El Paso, Tex.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 396-405.

Large monolithic solar photovoltaic panels are in initial pilot production. These panels utilize CdS deposited by spray pyrolysis with a Cu(x)S layer formed by dipping in cuprous ion solution. To gain a better understanding of the structure of such films and to assure a basic level of film quality, a field emission scanning electron microscope was used to observe these films. It was necessary to develop specimen preparation techniques which allowed rapid sample cycle time and which could clearly show as many important aspects of film and junction structure as possible. These specimen preparation techniques encompass film fracture for cross sections and differential etching to separate the individual layers in multilayered structures. (Author)

A80-46730 Photoelectrochemical solar cells. H. Gerischer (Max-Planck-Gesellschaft zur Förderung der Wissenschaften, Fritz-Haber-Institut, Berlin, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 408-423, 54 refs.

The paper demonstrates that the energy conversion mechanism in photosynthesis based on a photoelectrochemical process has a low probability of reaching high efficiency at reasonable cost. The best possibilities are cells with semiconductor/redox electrolyte junctions in which a Schottky barrier is produced due to difference in work functions. Examples of such systems are given, noting that the most serious problem is the protection of the semiconductor against photocorrosion.

A.T.

A80-46731 CdTe homojunctions solar cells. D. Lincot, R. Triboulet, Y. Marfaing, G. Cohen-Solal, and M. Barbé (CNRS, Laboratoire de Physique du Solide, Bellevue, Hauts-de-Seine, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 424-431. 6 refs. Commission of the European Communities Contract No. 206-76-ESF.

The preparation and characteristics of shallow homojunction CdTe solar cells are reported. The homojunctions were prepared by a modified close-spacing vapor-phase epitaxy technique, in which a thin layer of doped p- or n-type CdTe is deposited on a single-crystal n- or p-type CdTe substrate. Measurements of the dark currentvoltage characteristics, capacity-voltage dependence and currentvoltage characteristics under air mass zero illumination are presented which are found by laser cartography and numerical simulation to be attributable to surface resistances on the order of a few megaohms rather than a voltage-dependent quantum efficiency. Under these conditions, generated photocurrent densities of about 25 mA/sq cm are obtained under air mass zero illumination with an open circuit voltage of about 800 mV implying theoretical efficiency of over 10 percent. Two solutions to the problem of surface resistance allowing the attainment of this efficiency are indicated. A.L.W.

A80-46732 Oxide/semiconductor photovoltaic heterojunctions based on CdTe or InP. R. H. Bube, F. G. Courreges, A. L. Fahrenbruch, and M. J. Tsai (Stanford University, Stanford, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 432-439, 11 refs. Research supported by the U.S. Department of Energy, ERDA, and NSF.

The properties of oxide/semiconductor surfaces and interface have been investigated using indium-tin oxide as the large bandgap member of the heterojunction, deposited by RF sputtering on single crystal substrates of p-type CdTe or InP. It is shown that any post-deposition heat treatment degrades the performance of the ITO/CdTe cells, but a moderate post-deposition heat treatment is essential to realize maximum efficiency in the ITO/InP cells. V.T.

A80-46734 Concentration and temperature performances of GaAs-GaAlAs solar cells. E. Fanetti, G. Fiorito, and C. Flores (Centro Informazioni, Studi ed Esperienze S.p.A., Milan, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 447-454. 8 refs. Research supported by the Centro Informazioni, Studi ed Esperienze, S.p.A., and Ente Nazionale per l'Energia Elettrica.

GaAs-GaAlAs solar cells have been grown by LPE technique. Particular attention was paid to the adjustment of the parameters affecting the series resistance such as layer doping and thickness and contact pattern design. The conversion efficiency of some solar cells was measured up to 1000 suns. The temperature dependence of the open circuit voltage, the short circuit current, the fill factor, and the efficiency was determined. The experimental data were compared with the theoretical curves. The series resistance reduction is still the

main goal in order to achieve solar cells to be used in high concentration hybrid systems. (Author)

A80-46735 Photovoltaic power generators in space. K. K. Reinhartz (ESA, European Space Research and Technology Centre. Noordwijk, Netherlands). In: Photovoltaic Solar Energy Conférence, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 456-468, 19 refs.

A review of the requirements, current technology, and development trends of solar space generators is presented. Requirements for solar generators in space including efficiency, corrosion resistance of solar panels, and resistance to thermal cycling are discussed; the increased efficiencies through the use of lower ohmic base material, shallow junctions to increase blue sensitivity, and nonreflective surfaces to reduce optical losses are described. The reliability of a photovoltaic space solar generator can be affected by failures of interconnections, and 'hot spot' and/or reverse breakdown failures. Solar satellite power systems are considered, noting that compared to conventional terrestrial applications, solar systems must be very light to minimize the transport cost into space and their sensitivity to radiation must be very low. A.T.

Requirements for future Air Force satellite solar power technology. J. F. Wise (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 469-476. 16 refs.

The paper discusses the U.S. Air Force solar power technology developments for future satellites. The near-term capability of silicon solar cells will be in the 14-16% efficiency range; the potential of GaAs solar cells is examined, noting the high risk challenges of the multibandgap solar cells which may lead to efficiency in the 25-35% range. It was shown that current power system capabilities in synchronous orbit are under 5 kW; a power level of about 8 kW is achievable with the use of the GaAs solar cell and nickel hydrogen battery technology.

Pulsed measurement of solar cell spectral response. J. C. Larue (ESA, European Space Research and Technology Centre, Noordwijk, Netherlands). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceed-Dordrecht, D. Reidel Publishing Co., 1979, inas. p. 477-486. 7 refs.

A method is described for improving the accuracy of measurement of solar cell spectral response by using a powerful photographic flash-lamp to increase illumination intensity with a set of narrow band-pass interference filters. The method was tested by crosschecking spectrally calibrated reference standards and by computing short-circuit currents of 10 test cells from the spectral response measured, and from AMO and AM1.5 sunlight spectral distribution. The accuracy obtained by both tests was in the range of plus or A.T. minus 2%.

A80-46738 A low cost solar simulator for testing photovoltaic terrestrial solar power cells and modules. A. D. Haigh and I. M. Shaw (Ferranti Electronics, Ltd., Manchester, England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 487-494.

The paper deals with the design and construction of a table-top, pulsed solar simulator (TTPSS) produced at a much lower cost than that of large area pulsed solar simulator (LAPSS). A close approximation to air mass one spectral content and irradiance was simulated over a test area of 600 sq mm, each radiation pulse measuring a point on the device I-V characteristic. The simulator closely reproduced device characteristics measured on the LAPSS; its space requirements and costs of construction and operation are low. Variations were shown in the power distribution between line and continuous spectra with xenon decay when measuring the spectral content.

Photovoltaic generators using optical concentration. R. Mertens (Leuven, Katholieke Universiteit, Heverlee; Nationale Fonds voor Wetenschappelijk Onderzoek, Brussels, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. recht, D. Reidel Publishing Co., 1979, p. 496-506. 29 refs.

A review of the state-of-art in the development of photovoltaic systems with optical concentration is presented. Several prototypes can reach the 1982 \$2/watt cost goal using conventional geometrical optics and Si solar cells; their actual global efficiency is about 9%. Considerably higher efficiencies are required for a break-even point for central utility uses; these very high efficiencies can be achieved through the multicell concept in which two or more cells with a different bandgap are placed in the same concentrator.

A80-46740 Operation of multi-bandgap concentrator cells with a spectrum splitting filter. H. A. Vander Plas, R. L. Moon, L. W. James, T. O. Yep, and R. R. Fulks (Varian Associates, Palo Alto, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 507-514. 12 refs. U.S. Department of Energy Contract No. 07-6953.

Silicon and Al(0.93)Ga(0.07)As/Al(0.17)Ga(0.83)As solar cells combined with a spectrum splitting filter are described. Efficiencies of 27% at 113 suns and 26% at 489 suns have been obtained. The fabrication and operation of a spectral-splitting system are covered.

A80-46741 Fluorescent planar concentrators - Performance and experimental results. A. Goetzberger, K. Heidler, V. Wittwer, A. Zastrow, G. Baur, and E. Sah (Fraunhofer-Institut für angewandte Festkörperphysik, Freiburg im Breisgau, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings D. Reidel Publishing Co., 1979, p. 515-523, 9 refs. Bundesministerium für Forschung und Technologie, Contract No. ET-4190-A.

A study of fluorescent concentrator efficiency and stability is presented. These concentrators operate with fluorescent light conversion and guidance by total internal reflection, and they can collect diffuse radiation as well as divide the incoming solar spectrum into wavelength fractions. Outdoor measurements of optical and electrical efficiency under 'direct sun' and 'no direct sun' conditions showed an enhancement of optical efficiency by a factor of 1.5 for the 'no direct sun' case due to the reduction of the non-useful IR-part of the input spectrum and a blue shift of the visible part. The outdoor stability test results of the degradation in optical efficiency of a yellow collector are presented; after 250 days of exposure to the sun, the collector still showed 58% of its initial efficiency.

A80-46742 Solar cells with concentrating collectors and integrated heat use system. M. Simon, H. Pfeiffer, J. Kohlmannsperger, and S. Gall (M.A.N. Neue Technologie, Munich, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 541-549.

The paper describes the development of a 4 KWe concentrating silicon cell module with 4 heliostatic mounted cylinder parabolic troughs and the concentration factor of 20 to 40. A model calculation for the optimization of the concentration factor is presented, noting that specific collector costs, will be optimal in the 10-50 concentration range. Cell module 1 m long will be tested at cell temperatures from 20 to 120 C; concentration, focusing, shadowing, and rim angle adaptation were determined in outdoor tests of a preprototype consisting of one 4 m long trough and a complete cell module with a concentration of 20 and a load simulator water pump.

A80-46743 Integration of photovoltaic generation into a large generating system. G. C. Manzoni, A. Taschini (Ente Nazionale per L'Energia Elettrica, Milan, Italy), and L. Salvaderi (Ente Nazionale per L'Energia Elettrica, Rome, Italy): In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 552-562. 10 refs.

A80-46744 Dc to ac power conditioning for photovoltaic arrays and utility interfacing. J. L. Watkins (Solar Energy Research Institute, Golden, Colo.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p.

The paper discusses various dc to ac conversion techniques for photovoltaic systems and the components used to implement them. Emphasis is placed on line-commutated and self-commutated inversion. The requirements dictated by the use of photovoltaics as a dc source are analyzed.

V.T.

A80-46745 Analysis, design and realization of a 5 kW photovoltaic generator. D. Keaveny and C. Kruse (Telefunken AG, Wedel, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 584-592.

The paper describes a 5 kW photovoltaic power supply system for driving a VHF transmitter. This solar generator has 486 modules made with square-shaped solar cells; the power supply also contains a storage battery and a self-contained monitoring system. The generator will be installed in Berlin, West Germany. A small monitoring unit has been in operation since 1978 for on-site measurements. A.T.

A80-46746 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries. G. R. Smekens, G. Carbonelle, and R. A. Gaasch (Energies Nouvelles et Environnement, S.A., Brussels, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 601-609.

A80-46747 Batteries for solar electricity. J. Jensen, C. Perram (Odense, Universitet, Odense, Denmark), and R. M. Dell (Atomic Energy Research Establishment, Harwell, Berks., England). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 610-621. 8 refs. Research supported by the Department of Industry of England; Commission of the European Communities Contracts No. 315-78-EEDK; No. 316-78-EFLIK.

The paper examines the small scale storage of solar electricity in cases when no main back-up supply is available. A systems optimization study of the solar cell/battery is included with an analysis of solar cell size based on battery capacity for specific insolation patterns and load constraints. Various types of batteries are considered, noting that the following parameters are important: cost, low maintenance, long lifetime and large number of cycles, high charge/discharge efficiency, and good charge retention. The sealed lead-acid and nickel-cadmium batteries are presently available; it is possible that nickel-zinc and lithium-organic electrolyte batteries will be useful in the future.

A80-46748

Research issues for low cost photovoltaic cells.

J. R. Burke and D. L. Feucht (Solar Energy Research Institute,
Golden, Colo.), In: Photovoltaic Solar Energy Conference, 2nd,
Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p.

624-630.

The long term goal of the U.S. Photovoltaic Program is solar-to-electrical energy conversion at a cost of 10-30 cents per peak watt. Two approaches offer promise of meeting this goal. One would make use of solar cells employing thin films of polycrystalline or amorphous semiconductors on low cost substrates. The photovoltaic conversion efficiency requirement of 10% or greater dictates,

however, that such materials must have electronic properties that are not drastically degraded from those of their single crystal counterparts. The other approach would incorporate solar concentration and either moderate efficiency (10%) luminescent cells or high technology, high efficiency (30%) multibandgap cells. Some of the fundamental investigations needed to examine the efficiency potential of each of these approaches are outlined. (Author)

A80-46749 Numerical modelling of a solar cell in three dimensions. P. U. Calzolari (Bologna, Università, Bologna, Italy) and A. M. Mazzone (CNR, Laboratorio LAMEL, Bologna, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 631-638. 5 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A numerical analysis in three dimensions of comb shaped cells is presented. The analysis assumes the equipotentiality of the bus bar and the gradual variation of photovoltage on the surface. The range of grid parameters examined includes the characteristics of both standard evaporated and screen-printed cells. This method has been applied in a study of possibilities of both types of cells in the low-medium concentration range.

A.T.

A80-46752 \* Theoretical performance of multi-layer grid patterns for solar cells. A. Flat and A. G. Milnes (Carnegie-Mellon University, Pittsburgh, Pa.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 654-661. 11 refs. Grant No. NGR-39-087-021.

Multilayer grid patterns consist of fine closely spaced grid lines overlaid by coarser patterns of wider and thicker grid lines to collect the current from the finer grids with low series voltage drop and low active-layer sheet losses. An analytical approach leads to closed form solutions with simple relationships between the power losses in the active layer, in the grid and shadowing losses for optimum design proportions. The results show that multilayer grids, with line thickness equal to line width, greatly reduce losses in cell efficiency under concentration conditions of high current collection. (AlGa)As-pn GaAs cells of areas 1-25 sq cm and sheet resistance 40 ohms/square are considered. Also the performance of a n/p GaAs cell of dimensions 10 x 10 cm is studied. With optimized grid patterns high efficiencies are predicted for large area cells. (Author)

A80-46753 Survey of semiconductor combinations for optimum heterojunction thin film solar cells. G. Vanhoutte and H. Pauwels (Gent, Rijksuniversiteit, Ghent, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 662-670. 14 refs.

A80-46755 Semiconductor-electrolyte solar cells for the photoelectrochemical reduction of carbon dioxide to organic fuel. M. Halmann and B. Aurian-Blajeni (Weizmann Institute of Science, Rehovot, Israel). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 682-689: 12 refs.

A80-46756 \* Some characteristics of low-cost silicon sheet. K. M. Koliwad, T. Daud, and J. K. Liu (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 710-717. 6 refs. Research sponsored by the U.S. Department of Energy.

The paper discusses structural defects in low-cost silicon sheets and their effect on the electronic properties related to solar cell performance. Experimental data are presented on the influence of grain boundaries on minority carrier diffusion length, impurity

defect interaction, and variable surface recombination velocity. An analytical model of the effect of grain boundaries on solar cell performance is constructed based on these results.

A.T.

A80-46757 • Low cost processes for silicon. R. Lutwack (California Institute of Technology, Jet Propulsion Laboratory, Pæadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 718-725.

The paper describes the multiple process development of low cost processes for manufacture of silicon. A support program includes subtasks for the modeling of reactions and reactors, chemical engineering and solid-state physics studies, and development of impurity concentration measurement procedures. The preliminary economic analyses indicate total product costs ranging from \$5.00 to \$8.73/kg based on 1000 MT/yr plants. In the studies of impurity effects, a model which considers that degradations of solar cell performance by impurities are primarily due to decreases in base diffusion length was constructed from experimental data. A.T.

A80-46758 On the effects of boron and phosphorus primary impurities in p-type silicon material for solar cells. L. Giarda, A. Parisi, S. Pizzini (Montedison S.p.A., Istituto G. Donegani, Novara, Italy), M. Finetti, and P. Negrini (CNR, Laboratorio LAMEL, Bologna, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 726-733. 8 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A80-46763 Improvement of phosphorus diffused silicon solar cells by laser treatment. E. Fogarassy, R. Stuck, J. C. Muller, A. Grob, J. J. Grob, P. Siffert (CNRS, Centre de Recherches Nuclèaires de Strasbourg, Strasbourg, France), Y. Salles, and D. Diguet (La Radiotechnique Compelee, Caen, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings Dordrecht, D. Reidel Publishing Co., 1979, p. 768-775. 13 refs.

The paper demonstrates that the inactive excess of phosphorus which results from the maximum of 4  $\times$  10 to the 20th/cu cm of electrically active phosphorus introduced into silicon by diffusion, while the total phosphorus concentration may be higher than 10 to the 21st/cu cm, can be partly reactivated by irradiation with short ruby laser pulses. The laser melts the silicon surface, thereby lowering silicon sheet resistances. A study of this effect and the influences of diffusion and irradiation conditions was made using SIMS, RBS, electrical and optical methods.

A80-46764 Influence of the double exponential on the efficiency and the yield of screen printed solar cells. P. Lauwers, L. Frisson, R. Janssens, R. Mertens, R. Govaerts, and R. Van Overstraeten (Leuven, Katholieke Universiteit, Heverlee, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 776-783. 6 refs. Research supported by the Instituut tot Aanmoediging van het Wetenschappelijk Onderzoek in Nijverheid en Landbouw and Nationale Fonds voor Wetenschappelijk Onderzoek.

The paper demonstrates that screenprinting by metallization must be well controlled so that the solar cell characteristics do not degrade during the high temperature firing step. The effect of the process on the double exponential parameters m2, I(O2), and the shunt resistance are shown and compared with those of evaporated cells. The impact of other parameters such as the firing temperature and profile, and paste composition on the cell parameters is discussed, noting that they can be optimized to yield maximum efficiencies which average 11.8%. The influence of these parameters on process yield, which can reach 90%, is described.

A80-46766 A computer model for polycrystalline Si n/plus//p solar cells. S. Makram-Ebeid (Laboratoire d'Electronique et de Physique Appliquée, Limeil-Brévannes, Val-de-Marne, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 792-799. 6 refs.

A numerical model for calculating the spectral response and AM1 photocurrent for a photocell containing planar recombining faults is presented. The distance between faults is assumed to follow the Poisson distribution in accordance with direct EBIC observations; the recombination on the planar faults is considered to be in accordance with the Shockley-Read-Hall expression. The model provides accurately measured spectral response at different temperatures for photocells made on RAD polysilicon sheets; the parameters used for simulation suggest that the temperature change of the photocurrent is mainly due to a decrease of the planar fault recombination velocity with increased temperature.

A.T.

A80-46767 High efficiency silicon solar cell for concentrator systems. M. Conti, A. Modelli, and G. Vento (SGS-ATES Componenti Elettronici S.p.A., Milan, Italy). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 800-807. 9 refs. Research supported by the Consiglio Nazionale delle Ricerche; European Economic Communities Contract No. 456-78-1-ESI.

The paper describes the design, fabrication, and evaluation of a 2-in. high efficiency solar cell suitable for concentrator systems. The cell is manufactured by diffusing a 0.3 micron thick N(+) region in the front side of a 2-in. P-type silicon wafer and alloying aluminum onto the backside. An antireflecting film of plasma-deposited Si3N4 is coated on the front side of the wafer; the front part consists of a comb-shaped metal grid on Ti, Pd, and Ag of octagonal symmetry. The cell is soldered on a steel frame coated with nickel and a tin-lead alloy which provide a good electrical contact with an efficient heat sink. Efficiency performances of this cell as a function of concentration ratio and temperature show values over 17% AM1 at 28 deg and 50 suns obtained with FF greater than 74%.

A80-46768 High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination. A. Cuevas, J. Sangrador, A. Luque, J. M. Ruiz, and G. Sala (Madrid, Universidad Politécnica, Madrid, Spain). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p.

The use of two different structures as double-sided illuminated solar cells is considered: a n(plus)pn(plus) structure (transcell) and a vertical multijunction edge-illuminated cell. Efficiencies between 13 and 15.5 percent have been measured for the transcell under illumination levels ranging from 0.5 to 15 equivalent AM1 suns; the related efficiency for the vertical multijunction (VMJ) cell varies from 8.5 to 11.5 percent. The spectral external quantum efficiency measured for the transcell is greater than that of a conventional cell in the IR region due to its rear collection effect. The VMJ cell has a spectral response relatively higher than that of the conventional cell both in the IR and the UV regions, although it is lower in absolute value. (Author)

A80-46769 Advances in theory, fabrication and applications of bifacial solar cells. Y. Chevalier and F. Dueñas (Centro de Investigación y de Estudios Avanzados, Mexico City, Mexico). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 817-823. 8 refs.

A80-46770 Integrated Cu2S-CdS thin film solar cell generator. W. Arndt, G. Bilger, G. H. Hewig, F. Pfisterer, H.-W. Schock, J. J. Wörner, and W. H. Bloss (Stuttgart, Universität, Stuttgart, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin,

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West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 826-834, 12 refs.

Commission of the European Communities Contract No. 428-78ESD; Bundesminsterium für Forschung und Technologie Contract
No. ET-4045.

Large area Cu2S-CdS thin film solar cells can be produced with an efficiency of over 7%. The thin film technology, which is used for the fabrication of the solar cells, enables production of integrated thin film solar cell generators with higher output voltages. Back contacts and n-type CdS layers are evaporated. The p-type Cu2Slayer is produced by dipping (Clevite process). The transparent front contact is fabricated on the front glass using silk screening and etching techniques. The front contact connects the different solar cells in series. Thin film solar cell generators are produced consisting of eight 7 x 7 sq cm large area solar cells. If one substrate glass and one front glass, each with an area of 14.5 x 28 sq cm, are used, generator efficiencies up to 2.4% are achieved. Using one front glass with the connecting grids and eight discrete  $7 \times 7$  sq cm substrate glasses with pn-junctions, which show similar IU characteristics, generator efficiencies up to 4.3% are achieved. (Author)

A80-46771 \* A preliminary 'test case' manufacturing sequence for 50 cents/watt solar photovoltaic modules in 1986. D. B. Bickler (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 835-842. 9 refs. Research sponsored by the U.S. Department of Energy.

The paper describes a 'test case' manufacturing process sequence for solar photovoltaic modules which will cost 50 cents/watt in 1986. The process, which starts with the purification of silicon grown into 75-mm-wide thin ribbons, is discussed, and the plant layout is depicted; each department is sized to produce 250 MW of modules/per year. The cost of this process sequence is compared to present technology at various companies showing considerable spread for each process; data are tabulated in a composite state-of-the-art cell processing cost summary for these processes.

A.T.

A80-46772 Photovoltaics commercialization readiness assessment. F. H. Morse (U.S. Department of Energy, Office of Conservation and Solar Applications, Washington, D.C.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 843-850.

The technical, market/economic, environmental, and institutional readiness of photovoltaic systems is discussed. Consideration is given to remote, or off-grid, applications and grid-connected applications. Two strategy options are outlined to promote the evolutionary development of the photovoltaic industry and to focus on penetration of energy-saving markets with new and improved low-cost photovoltaic technology.

A80-46773 \* Recent developments in the economic modeling of photovoltaic module manufacturing. R. G. Chamberlain (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 851-858. 6 refs.

Recent developments in the solar array manufacturing industry costing standards (SAMICS) are described. Consideration is given to the added capability to handle arbitrary operating schedules and the revised procedure for calculation of one-time costs. The results of an extensive validation study are summarized.

V.T.

A80-46775 Model for the photovoltaic effect in Cu2S-CdS solar cells in the backwall configuration. G. Bordure, M. O. Henry, J. L. Jacquemin, and M. Savelli (Montpellier II, Université, Montpellier, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West

Germany, April 23-26, 1979, Proceedings. drecht, D. Reidel Publishing Co., 1979, p. 868-873, 8 refs.

A80-46776 Photon loss analysis and design of thin-film planar junction Cu2S/CdS devices. J. A. Bragagnolo (Delaware, University, Newark, Del.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 882-889, 8 refs.

Planar junction devices with increased open-circuit voltage and projected efficiency over 10% have been obtained by solid-state reaction growth of Cu2S on unetched CdS layers. When the morphology of the Cu2S layer is changed, a substantial decrease in short-circuit current is observed. A quantitative photon loss analysis shows that achievable short-circuit current in present planar cells is limited by reflection and that re-emission of light after internal reflection in the cell is the primary contributor to the measured losses. Light trapping, caused by diffuse internal reflection leading to total internal reflection of outgoing photons at the outer cell boundary, reduces re-emission losses of thin-film polycrystalline CdS/Cu2S devices to a fraction of their value for a plane-parallel multilayer device. Variations in cell morphology, leading to changes in diffuse internal reflection, can explain the observed differences in reflection losses. This analysis can be useful in developing designs and processing techniques for increased photon collection efficiency of thin-film cells.

A80-46779 Optical and calorimetric measurements of cupreous sulphides thin films. F. Arjona, E. Elizalde, A. Feu, E. García Camarero, M. León, J. Llabrés, and F. Rueda (Madrid, Universidad Autónoma, Madrid, Spain). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Co., 1979, p. 903-908, 10 refs. Research sponsored by the U.S. Spain Cooperative Programme for Scientific Research.

The paper describes production of polycrystalline films of cupreous sulfide by sulfidation of copper and vacuum evaporation. The rate of chalcocite formation was monitored by electrical conductance measurements; optical transmittance and reflectance values of the pure chalcocite film direct and indirect transition gaps were 2.0 and 1.16 eV. Differential calorimetric measurements of pure chalcocite films show the beginning of the transformation at 88.0 plus or minus 1 C, with a single peak. The heat of transformation was 544 plus or minus 10 cal/mol, the activation energy was 0.17 eV, and the frequency factor was 166/s.

A80-46781 Preparation and analysis of Cu2O thin-film solar cells. J. Herion, B. Natsch, E. A. Niekisch, and G. Scharl (Kernforschungsanlage Jülich GmbH, Institut für Grenzflächenforschung und Vakuumphysik, Jülich, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 917-924. 8 refs.

The paper describes fabrication of Cu2O thin-film front wall solar cells utilizing partial thermal oxidation of Cu foil. This method produced efficiencies of 0.4%, open circuit voltages of 0.5 V, and fill factors of 0.45; the grain structure of the Cu2O layers was columnar and grain diameters larger than the layer thickness were obtained. The short circuit current is lower than that in more developed Cu2O cells, and the small fill factor is due to the high series resistance of the cells. Auger and XPS measurements show that this type of cell is of a heterojunction type rather than an MS structure.

A80-46782

Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure. F. Therez, H. Martinot, and D. Estève (CNRS, Laboratoire d'Automatique et d'Analyse des Systèmes, Toulouse, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 926-937. 7 refs.

A80-46783 Efficient GaAs shallow-homojunction solar cells on single-crystal GaAs and Ge substrates. J. C. C. Fan, and C. O. Bozler (MIT, Lexington, Mass.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 938-945. 5 refs. Research supported by the U.S. Department of Energy and U.S. Air Force.

The paper presents three types of all-CVD, single-crystal GaAs solar cells utilizing a shallow-homojunction n(+)-p-p(+) structure without a Ga(1-x)Al(x)As window. Conversion efficiencies exceeding 20% at AM1 have been obtained for 1 cm x 0.5 cm cells incorporating p and n(+) layers grown by chemical vapor deposition on single-crystal p(+) substrates.

A80-46784 On the influence of an interfacial oxide layer on Au/n-GaAs Schottky barrier solar cells. R. L. van Meirhaeghe, E. S. Verspurten, F. Cardon, and W. P. Gomes (Gent, Rijksuniversiteit, Ghent, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p.

Dordrecht, D. Reidel Publishing Co., 1979, p 946-951. 8 refs.

A80-46786

AlSb as a potential photovoltaic material. G.
A. Armantrout and J. H. Yee (California, University, Livermore, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 960-967. 13 refs. Contract No. W-7405-ENG-48.

The performance at AM1 of an AISb homojunction device is studied theoretically and experimentally. It is noted that AISb is of interest due to the relative abundance and relatively low cost of AI and Sb. Preliminary measurements of Schottky barrier cells made from AISb crystals have yielded cells with J(sc) about 1.2 ma/sq cm and V(oc) equal to 66 mV.

V.T.

A80-46787 'AISb as a candidate material for photovoltaic solar energy conversion. M. Leroux, C. Vérié (CNRS, Laboratoire de Physique des Solides, Meudon, Hauts-de-Seine, France), A. Tromson-Carli, and P. Gibart (CNRS, Laboratoire de Magnétisme, Meudon, Hauts-de-Seine, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 968-975. 10 refs. Research supported by the Délégation Générale à la Recherche Scientifique et Technique and Centre National de la Recherche Scientifique.

A80-46788 \* Testing flat plate photovoltaic modules for terrestrial environment. A. R. Hoffman, J. C. Arnett, and R. G. Ross, Jr. '(California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 978-986. 8 refs. Research supported by the U.S. Department of Energy and NASA.

New qualification tests have been developed for flat plate photovoltaic modules. Temperature cycling, cyclic pressure load, and humidity exposure are especially useful for detecting design and fabrication deficiencies. There is positive correlation between many of the observed field effects, such as power loss, and qualification test induced degradation. The status of research efforts for the development of test methodology for field-related problems is reviewed.

V.L.

A80-46789 Determination of the spectral distribution of global radiation with a rapid spectral radiometer and its correlation with solar cell efficiency. W. Arndt, W. H. Bloss, and G. H. Hewig (Stuttgart, Universität, Stuttgart, West Germany). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 987-994. 9 refs. Bundesministerium für Forschung und Technologie Contract No. ET-4045.

A80-46790 \* Physical/chemical modeling for photovoltaic module life prediction. J. Moacanin, W. F. Carroll, and A. Gupta (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 995-1001. Research supported by the U.S. Department of Energy and NASA.

The paper presents a generalized methodology for identification and evaluation of potential degradation and failure of terrestrial photovoltaic encapsulation. Failure progression modeling and an interaction matrix are utilized to complement the conventional approach to failure degradation mode identification. Comparison of the predicted performance based on these models can produce: (1) constraints on system or component design, materials or operating conditions, (2) qualification (predicted satisfactory function), and (3) uncertainty. The approach has been applied to an investigation of an unexpected delamination failure; it is being used to evaluate thermomechanical interactions in photovoltaic modules and to study corrosion of contacts and interconnects.

A.T.

A80-46791 Cassegrain solar concentrators for photovoltaics. M. H. Cobble, E. Lumsdaine, W. C. Hull, and R. M. Wabrek (New Mexico State University, Las Cruces, N. Mex.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1011-1020.

A solar concentrator consisting of a paraboloid of revolution that tracks the sun, and an hyperboloid of revolution reflector that has a focus in common with the paraboloid is analyzed using a three-dimensional ray trace to determine the image shape and the concentration to be obtained for various eccentricities of the hyperboloid when used with a 152.4 cm diameter paraboloid (f = 64.88 cm). The concentration for a non-uniform sun, a uniform sun and the concentration with mirror imaging errors is determined as a function of image radius. Silicon photovoltaic cells for use in this concentrator are tested at low concentration, and some preliminary current-voltage results are given. (Author)

A80-46792 Hybrid system consisting of silicon solar cells with concentrators and heat pump. M. S. Stojanovic and L. S. Milinkovic (Institut za Nuklearne Nauke, Belgrade, Yugoslavia). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1021-1026.

The paper describes a solar hybrid system consisting of silicon photovoltaic cells with concentrators and a heat pump. Heat energy can be added by the heat pump driven by electric power generated in the same solar cells in addition to low quality heat energy obtained by cooling of the cells. The hybrid system is autonomous and can be used as a refrigerator. Analysis of this system based on characteristics of commercial units, such as silicon solar cells, Fresnel concentrators, and heat pump, shows the economic potential of solar cells for the production of electricity, and that its conversion to heat energy through a heat pump is practical.

A80-46793

20 kW gallium arsenide photovoltaic dense array for central receiver concentrator applications. J. A. Cape, R. Sahai, and J. S. Harris (Rockwell International Science Center, Thousand Oaks, Calif.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 1027-1034. U.S. Department of Energy Contract No. 07-7274.

A feasibility study of photovoltaic subsystems on a central receiver tower on which highly concentrated sunlight is focused by a large field of mirrors is presented. The subsystem used, called a Dense Array, can achieve nearly 100% active area utilization of the incident solar flux; this is accomplished by overlapping a series of solar cell modules in a shingle-like manner, so that nonactive elements are shaded for insolation. The array will produce 20 kW with a frontal area of 0.13 sq m, and it consists of four electrically

parallel panels; each panel consists of 16 modules of 16 GaAs cells each, resulting in a system output of about 230 V and 80-85 amp at 1000 suns AM1.

A80-46794 Engineering studies on the optimization of the collection subsystem of A I MW photovoltaic facility. L. Selles and A: Euvrard (SERI-Renault Engineering, Bois-D'Arcy, Yvelines, France). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1054-1064. 10 refs. Commission of the European Communities Contract No. 474-78-4.

A80-46795 Influence of meteorological conditions on the design of solar energy do-ac inverters. D. Baert, A. De Vos, and G. Van Hoogenbernt (Gent, Rijksuniversiteit, Ghent, Belgium). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979, p. 1065-1073.

A80-46796 \* Description of photovoltaic village power systems in the United States and Africa. A. F. Ratajczak and W. J. Bifano. (NASA, Lewis Research Center, Cleveland, Ohio). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings. Dordrecht, D. Reidel Publishing Co., 1979; p. 1087-1095.

The paper describes the designs, hardware, and installations of NASA photovoltaic power systems in the village of Schuchuli in Arizona and Tangaye in Upper Volta, Africa. The projects were designed to demonstrate that current photovoltaic system technology can provide electrical power for domestic services for small, remote communities. The Schuchuli system has a 3.5 kW peak solar array which provides power for water pumping, a refrigerator for each family, lights, and community washing and sewing machines. The 1.8 kW Tangaye system provides power for pumping, flour milling, and lights in the milling building. Both are stand-alone systems operated by local personnel, and they are monitored by NASA to measure design adequacy and refine future designs.

A80-46797 Operational characteristics of a 60 kW photovoltaic system integrated with a utility grid: L. R. Suelzle (Delta Electronic Control Corp., Irvine; Calif.) and D. J. Roesler (U.S. Department of Energy, Washington, D.C.). In: Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings.

Dordrecht, D. Reidel Publishing Co., 1979, p. 1096-1103. Research supported by the U.S. Department of Energy and U.S. Army.

A80-46815 # A study of the heat-induced fracture characteristics of materials under intense radiant heating (Issledovanie kharakteristik teplovogo razrusheniia materialov pri intensivnom radiatsionnom nagreve). V. V. Pasichnyi, V. S. Dverniakov, E. S. Podlesnaia, and A. D. Kondratenko. Kosmicheskie Issledovaniia na Ukraine, no. 12, 1978, p. 65-69. 6 refs. In Russian.

A solar furnace is used to study the fracture characteristics of heat insulation materials under intense radiant heating. The normal emissivity, surface temperature, fracture rate, and effective enthalpy have been determined experimentally for crystalline mica specimens as a function of heat flow in the range 100 - 1000 W/sq cm. The results of a petrographic analysis of the material tested are presented.

A80-46894 # Radiation effects on solar cells. W. P. Rahilly (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: Space systems and their interactions with earth's space environment. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 365-385. 43 refs.

The effects of the trapped particle radiation environment on photovoltaic cells in earth orbit are discussed. The types of damage to the semiconductor material brought about by the impact of high-energy electrons or protons and the results and means of

protecting against this damage are considered. Recent improvements in the efficiency and radiation resistance of silicon solar cells and GaAs solar cells are discussed, with particular emphasis on the use of new semiconductor and dopant material properties. The emphasis of space power research and development programs for the near and farerm are indicated, and it is noted that despite the trend to GaAs and later multiple bandgap cascaded cells, silicon cells may be in use far beyond 1990.

A.L.W.

A80-46899 \* # Environmental protection of the solar power satellite. P. H. Reiff, J. W. Freeman (Rice University, Houston, Tex.), and D. L. Cooke: In: Space systems and their interactions with earth's space environment. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 554-576. 26 refs. Research supported by the Brown Foundation; Contract No. NAS8-33023.

This paper examines theoretically several features of the interactions of the Solar Power Satellite (SPS) with its space environment. The leakage currents through the kapton and sapphire solar cell blankets are calculated. At geosynchronous orbit, this parasitic power loss is only 0.7%, and is easily compensated by oversizing. At low-earth orbit, the power loss is potentially much larger (3%), and anomalous arcing is expected for the high-voltage negative surfaces. Preliminary results of a three-dimensional selfconsistent plasma and electric field computer program are presented, confirming the validity of the predictions made from the onedimensional models. Lastly, the paper proposes magnetic shielding of the satellite, to reduce the power drain and to protect the solar cells from energetic electron and plasma ion bombardment. It is concluded that minor modifications from the baseline SPS design can allow the SPS to operate safely and efficiently in its space environment.

A80-46933 Solar selective black cobalt - Preparation, structure, and thermal stability. G. B. Smith, A. Ignatiev, and G. Zajac (Houston, University, Houston, Tex.). Journal of Applied Physics, vol. 51, Aug. 1980, p. 4186-4196. 22 refs. Research supported by the U.S. Department of Energy.

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The paper discusses electroplating techniques for producing black cobalt coatings stable at 500 C in air. Plated cobalt sulfides, cobalt oxide-hydroxides, and cobalt oxide prepared by thermal oxidation of electroplated cobalt were analyzed before and after air exposures for long time periods in the 300-500 C range. The sulfide black cobalt was not acceptable due to severe thermal degradation; the plated oxide is a good selective absorber to 400 C; and the thermally oxidized black is satisfactory to higher temperatures, but degrades at 500 C. SEM, AES, and XPS studies show that the high solar absorptance of the acceptable black cobalt coatings results from the continuation of a porous outer layer grading into nondense CoO or Co3O4, and that absorption is intrinsic but not due to metal particles as in black chrome.

A.T.

A80-46937 I-V relationship for the Cu2S/CdS solar cell. G. L. Lazarev (Datacomp Corp.; Philadelphia, Pa.). Journal of Applied Physics, vol. 51, Aug. 1980, p. 4257-4259. 10 refs.

The diode equation, which describes the behavior of the Cu2S/CdS solar cell, was derived from first principles. The key results are the independence of the open-circuit voltage from the field in CdS and an explanation of the intersection of the dark and illuminated portions of the I-V curves. The limiting factors and correlation with experimental results are discussed. (Author)

A80-46951 Limiting efficiencies of ideal single and multiple energy gap terrestrial solar cells. C. H. Henry (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). *Journal of Applied Physics*, vol. 51, Aug. 1980, p. 4494-4500. 24 refs.

The maximum efficiencies of ideal solar cells are calculated for both single and multiple energy gap cells using a standard air mass 1.5 terrestrial solar spectrum. The calculations of efficiency are made by a simple graphical method, which clearly exhibits the contribu-

tions of the various intrinsic losses. The maximum efficiency, at a concentration of 1 sun, is 31%. At a concentration of 1000 suns with the cell at 3000 K, the maximum efficiencies are 37, 50, 56, and 72% for cells with 1, 2, 3, and 36 energy gaps, respectively. The value of 72% is less than the limit of 93% imposed by thermodynamics for the conversion of direct solar radiation into work. Ideal multiple energy gap solar cells fall below the thermodynamic limit because of emission of light from the forward-biased p-n junctions. The light is radiated at all angles and causes an entropy increase as well as an energy loss.

(Author)

A80-46952 High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy. R. R. Saxena, V. Aebi, C. B. Cooper, III, M. J. Ludowise, H. A. Vander Plas, B. R. Cairns, T. J. Maloney, P. G. Borden, and P. E. Gregory (Varian Associates, Inc., Palo Alto, Calif.). Journal of Applied Physics, vol. 51, Aug. 1980, p. 4501-4503. 8 refs. Research supported by the U.S. Department of Energy.

Conversion efficiency of 23% at 369 suns has been achieved for packaged AlGaAs/GaAs solar cells fabricated by organometallic vapor phase epitaxy. The design considerations and the solar cell performance in concentrated sunlight are described. (Author)

A80-46953 Efficiency of quantum-utilizing solar energy converters in the presence of recombination losses. R. T. Ross and J. M. Collins (Ohio State University, Columbus, Ohio). *Journal of Applied Physics*, vol. 51, Aug. 1980, p. 4504-4507. 16 refs. Research supported by the U.S. Department of Energy; NSF Grant No. PCM-76-11655.

The paper discusses efficiency of quantum-utilizing solar energy converters in the presence of nonradiative recombination losses which limit the optimal absorbance of a solar energy converter. An expression is derived for the optimal absorbance of a flat-plate device for the case when nonradiative losses exceed radiative losses; for a specified output potential, the optimal threshold photon energy increases as kTln(kappa), where kappa is the ratio of nonradiative to radiative decay rates within the absorbing material. The maximum efficiency of a terrestrial flat-plate device falls from 0.334 when kappa is zero, to 0.316 when kappa is 1. Curves are presented which show the dependence of efficiency on the potential of the process driven, the threshold photon energy, and the relative rate of nonradiative decay.

A80-47043 Irradiance on the receiver of a general optical concentrator. R. P. Patera (Miami, University, Coral Gables, Fla.). Optical Society of America, Journal, vol. 70, Aug. 1980, p. 986-990. 7 refs.

A general expression is obtained for the maximum radiant power density at the receiver of a general optical concentrator in terms of the acceptance function and the input distribution of radiation. As an example of the result, the radiant power density for two- and three-dimensional symmetric and asymmetric ideal concentrators is found without reference to any particular concentrator design. For particular input distributions both two- and three-dimensional ideal asymmetric concentrators have greater power density than their symmetric counterparts. (Author)

A80-47139 Photoelectrochemical investigation on trigonal selenium film electrodes. W. Gissler (Commission of the European Communities, Joint Research Centre, Ispra, Italy). (Electrochemical Society, International Conference on Chemical Vapor Deposition, 7th, Los Angeles, Calif., Oct. 14-19, 1979.) Electrochemical Society, Journal, vol. 127, Aug. 1980, p. 1713-1716. 23 refs.

The photoelectrochemical properties of trigonal selenium films were investigated in view of a possible application in semiconductor liquid junction photo cells. A photo decomposition reaction of Se into hydrogen selenide was observed in acidic solutions. Only redox couples with a relatively anodic standard potential can prevent the decomposition process. The results are interpreted by a charge transfer process via interband states. Possible applications of Se-film electrodes are discussed. (Author)

A80-47141 Photoelectrochemical compatibility of n-WSe2 and n-MoSe2 with various redox systems. S. Menezes, F. J. DiSalvo, and B. Miller (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). Electrochemical Society, Journal, vol. 127, Aug. 1980, p. 1751-1758, 26 refs.

An investigation is presented which resolved photoelectrochemical reactions at n-WSe2 and n-MoSe2 in several redox electrolytes into hole transfer and photocorrosion components by hydrodynamically modulated 'rotating disk and ring disk electrode methods. Different n-WSe2 specimens have a range of current-potential behavior; both semiconductors have the same selectivity to redox couples with optimum photoelectrochemical output in I(-)/I2 solutions. The rotating disk methods show examples of efficient hole transfer, mixed solution oxidation-photocorrosion, and photocorrosion. The photopotential-current characteristics show that specific surface interactions strongly modify redox potential ordering. A.T.

A80-47151 Theoretical investigations into collection coefficient for Cu/2-x/S-CdS cells with allowance for surface states at interface. T. G. Averbukh and V. M. Evdokimov (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 3-7.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 1-5. Translation.

A80-47152 Metallic thermoelectric materials in solar thermoelectric generators. C. Agabaev, G. K. Kotyrlo, A. S. Stiagov, S. Khandovletov, and V. G. Sholopov (Akademiia Nauk Ukrainskoi SSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 8-11.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 6-9, 7 refs. Translation.

The possibility of utilizing metallic thermoelectric materials in solar thermoelectric generator structures is considered, and the structure of a solar thermoelectric generator is described. Results are reported for preliminary tests of a solar thermoelectric generator using 5-m concentrators. The economic characteristics of solar thermoelectric generators using metallic and semiconductor materials are compared. (Author)

A80-47153 Some electric and photoelectric properties of photodetectors based on epitaxial layers Si/x/Ge/1-x/ with diffused p-n junction. Kh. T. Akramov, A. S. Liutovich, K. L. Liutovich, and B. D. Iuldashev (Akademiia Nauk Uzbekskoi SSR, Institut Elektroniki; Tashkentskii Gosudarstvennyi Universitet, Tashkent, Uzbek SSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 12-15.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 10-13. 5 refs. Translation.

A80-47154 Design of a thermophotocell. S. M. Gorodetskii, E. K. Iordanishvili, and Iu. I. Ravich (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Leningrad, USSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 16-21.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 14-19: 8 refs. Translation.

Calculations are given for a thermophotocell (TPC) of a semiconductor device in which there is simultaneous photoelectric and thermoelectric conversion of radiant energy. Two types of TPC are considered: with common current through photocell and thermoelement and with electrically insulated (separated) photocell and thermoelement. (Author)

A80-47155 Estimating capacity of solar thermoelectric generator /STEG/ panels. I. I. Kokhova, Iu. N. Malevskii, and A. I. Tsvetkov (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 22-28.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 20-25. 6 refs. Translation.

Energy characteristics of a solar thermoelectric generator (STEG) panel without solar-flux concentration are considered. The design of such devices is no simple task. Several fully justified assumptions have been introduced in an attempt to obtain a solution convenient for engineering calculations.

(Author)

A80-47156 Solar cells for terrestrial applications. D. S. Strebkov, V. V. Zadde, T. I. Sur'ianinova, and L. P. Kudeshova (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 29-32.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 26-29. 6 refs. Translation.

Requirements for the structural design and fabrication of solar cells (SC) for terrestrial applications are considered. It is shown that it is desirable to develop SC having n+/p/p+ structure with two-sided photosensitivity through simultaneous diffusion of phosphorus and boron in silicon. The doped films are applied to wafers of silicon having solution-type compositions. Profiles are given for the distribution of impurities introduced, together with the working characteristics of the SC with illumination on different sides. The conversion efficiency of an SC using direct solar radiation and radiation reflected from the rear was 18%. (Author)

A80-47157 Experimental investigation of thermal characteristics of solar thermoelement block. T. Z. Abidov, T. Baimatov, and U. Kh. Gaziev (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 33-36.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 30-33, Translation.

An experimental investigation of the thermal characteristics has been carried out for a block of solar thermoelements. The thermal capacity and effective efficiency of the block have been determined for various heat-transport medium flow rates with different heat-exchanger designs employed.

(Author)

A80-47158
Investigation of the service life of aluminum mirrors on metal substrates at high temperatures. R. A. Zakhidov, A. Ismanzhanov, and L. A. Dubrowskii (Akademiia Nauk Uzbekskoi SSR, Tsentral'noe Proektno-Konstruktorskoe i Tekhnologicheskoe Biuro Nauchnogo Priborostroeniia, Uzbek SSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 37, 38.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 34, 35. Translation.

A80-47159 Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems. O. Azimov (Samarkandskii Gosudarstvennyi Universitet, Samarkand, Uzbek SSR) and R. R. Avezov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 39-41.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 36-38. Translation.

A80-47161 Analytic representation of distribution laws for energy structure of solar-radiation regime. R. B. Salieva (Tashkentskii Elektrotekhnicheskii Institut Sviazi, Tashkent, Uzbek SSR). (Geliotekhnika, vol. 15, no. 6, 1979, g. 64-69.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 62-67. 6 refs. Translation.

A80-47162 Investigation of temperature regime of singlestory house with solar heating system. S. O. Khatamov and M. M. Zakhidov (Akademiia Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 77-80.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 75-78. Translation.

Field observations were carried out over the period 1973-78 in order to determine the efficiency of a solar heating/cooling system installed in a one-story house with two three-room apartments (a useful area of 102 sq m). The solar heating system uses air as a heat-transport medium and 3-5 cm diameter stones as heat-storage material. In summer, the stone storage units are cooled at night by cool outside air, and the refrigerating capacity thus accumulated is employed to cool the premises. It was established experimentally, that over the 1975-76 heating season, the system provided a savings of 60% of the fuel required to heat the house. In summer, the difference between the average temperature of the outside air and that of the cooled apartment was 4.3 C.

V.L.

A80-47163 Investigation of high-voltage heterophotoconverters. B. A. Bazarov, A. B. Pinov, D. S. Strebkov, and M. K. Khadikov (Gorsk Agricultural Institute, USSR; Akademiia Nauk Turkmenskoi SSR, Fiziko-Tekhnicheskii Institut, Ashhabad, Turkmen SSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 81-83.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 79-81. 7 refs. Translation.

Results are reported for investigations of high-voltage heterophotoconverters (HHPC) based on a solid-state matrix of connected microelements. The Al(1-x)Ga(x)As-GaAs specimens were obtained by liquid epitaxy on substrates of gallium arsenide with subsequent application of the group-connection method. Investigations have shown that high-voltage heterophotoconverters may be effectively used for conversion of concentrated solar radiation. (Author)

A80-47164 Investigation of the characteristics of electrochemical coatings for solar-radiation collectors. M. M. Koltun, V. P. Molchanova, F. R. luppets, and I. P. Gavrilova (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR). (Geliotekhnika, vol. 15, no. 6, 1979, p. 84, 85.) Applied Solar Energy, vol. 15, no. 6, 1979, p. 82-84. Translation.

A80-47596 Solar-powered Rankine engine assists air conditioning systems with electrical generating capability. B. Dollars (Lennox Industries, Inc., Carrollton, Tex.), W. D. Batton (Barber-Nichols Engineering Co., Arvada, Colo.), and S. E. Scarborough (Honeywell, Inc., Minneapolis, Minn.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers.

Press, Inc., 1980, p. 343-348.

A80-47597 Photovoltaic systems design and performance.
G. W. Rhodes (BDM Corp., McLean, Va.). In: Energy utilization;
World Energy Engineering Congress, 2nd, Atlanta, Ga., October
29-31, 1979, Compiled Papers. Atlanta, Ga.,
Fairmont Press, Inc., 1980, p. 349-351.

The Commercial Application of a Photovoltaic Concentrator (CAPVC) project is reviewed with emphasis on the technical and institutional issues which affect alternate energy designs. Some results of a thorough systems analysis are: (1) a projection of a 365 day CAPVC building load profile; (2) three aperture spacing between collector rows minimizes intraarray shadowing while maximizing row density; (3) the CAPVC system has a predicted levelized bus bar energy cost of \$.14 per kilowatt hour. The system will have a peak output power of 50,000 W, and an operating voltage of 275 V; 84. 20-foot collector modules will be arranged in 28 rows, with a total collector aperture area of 5880 sq ft, and a collector concentration ratio of 30-42:1.

A80-47664 Note on the condensation of the vapor phase above a melt of iron oxide in a solar parabolic concentrator. A. Tofighi and F. Sibieude (CNRS, Laboratoire des Ultra-Réfractaires, Font-Romeu, Pyrénées-Orientales, France). International Journal of Hydrogen Energy, vol. 5, no. 4, 1980, p. 375-381. 18 refs.

A80-48008 # Simulation and a preliminary comparison of passive solar heating systems. R. E. Stotts, R. O. Warrington, and R. L. Mussulman (Montana State University, Bozeman, Mont.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-17. 8 p. 15 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by Montana State University.

A computer model was developed to simulate direction gain, indirect gain, isolated gain and natural passive solar heating systems. The simulation rates were verified using test data from the passive test cells at the National Center for Appropriate Technology. A 139 sq m home with standard insulation levels was used to compare the different passive solar heating techniques. Collector area and storage mass were identified for the direct gain, indirect gain and isolated

gain. The natural passive systems, which incorporates only south-facing windows for collector area and the mass of the house for storage, used several total window areas on the south side, the maximum of which was approximately 50 percent of the collector area for the other passive heating methods. Inside air temperatures and make-up energy requirements were compared for several different weather patterns. (Author)

A80-48011 # DEROB - A system for simulating the dynamic energy performance of passive solar structures. A. Arumi-Noe and M. Wysocki (Texas, University, Austin, Tex.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-21. 11 p. 9 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

An overview of DEROB, a system of FORTRAN programs capable of simulating the energy response of buildings composed of multiple thermally coupled volumes of arbitrary geometries and correctly interpreting the presence of shading devices, is presented. The physical and mathematical basis of DEROB's heat transfer algorithms is outlined. The results of validation studies are discussed which tested DEROB against empirical data obtained from 10 target structures (3,4,5). These test results show that DEROB can accurately simulate the thermal performances of a wide variety of functional and geometric conditions which are often met with when dealing with passively heated and cooled buildings (e.g. direct gain systems, water-walls, water Trombe walls, Trombe walls, convective loops, rock storage bins, greehousessun space systems, all of which may be modeled with or without the use of moveable insulation). (Author)

A80-48034 # Theoretical study of absorbed solar energy in multi-layer absorber coatings for receivers of solar concentrators. II-Heat transfer analysis. I. S. Taha and M. M. Elsayed (Jeddah, University, Jeddah, Saudi Arabia). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-105. 7 p. 11 refs. Members, \$1.50; nonmembers, \$3.00.

Analysis of steady heat transfer through a multi-layer coating is carried out. The coating is composed of a thin layer of a low emitting metal (such as silver) covered by a relatively thick semiconductor layer and two relatively thin absorbing layers. The materials of the three layers are assumed to diffuse the beam radiation homogeneously. The expression for the heat absorbed, derived in Part I, is used in the heat conduction equation to obtain temperature distribution within the coating and the useful heat transferred to the working fluid. (Author)

A80-48036 # Thermal stress in a composite cylinder by finite difference technique. V. N. Con (Stone and Webster Engineering Corp., Cherry Hill, N.J.), R. Ä. Heller, M. P. Singh (Virginia Polytechnic Institute and State University, Blacksburg, Va.), and L. D. Tuyen (Hercules, Inc., Wilmington, Del.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-107. 6 p. 11 refs. Members, \$1.50; nonmembers, \$3.00.

Temperature and stress time series have been generated in the tubular heat exchanger of a concentrator type solar collector. Hourly measurements of ambient temperature, solar radiation and wind speed were used as random, input time series to a finite difference solution of the heat transfer problem. The results indicate that significant alternating thermal stresses are generated. Tangential stress in the copper tube has been found to be the greatest stress component. Given the fact that the collector is subjected to alternating temperature changes daily and seasonally. As a result, over a long period of time, the induced stress may lead to life limiting fatigue. (Author)

A80-48038 # A two-dimensional analysis of flat plate airheating solar collectors. M. R. Diab, J. T. Pearson, and R. Viskanta (Purdue University, West Lafayette, Ind.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-117. 9 p. 22 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. EM-78-C-04-5366.

A realistic analysis is made of a general class of flat plate, air-heating solar collectors: The quasi-steady formulation considers the cases of multiple cover plates with airflow above, below, and both above and below the absorber plate. Recently developed methods of analyzing thermal radiation exchange are employed. The two-dimensional analysis of the collector performance proceeds to a nodal formulation; then a numerical technique is employed to solve the resulting set of nonlinear algebraic equations. The analysis considers the effects of collector inclination and beam and diffuse solar incident irradiation and accounts for both forced and natural convection. The results are used to study the parametric effects of airflow passage arrangement, number of cover plates, cover-toabsorber plate spacing, absorber-to-back plate spacing, airflow rate, inlet-to-ambient temperature difference, insulation thickness, and wind speed. The results of the parametric analysis are presented graphically. (Author)

A80-48150 Surface passivation of inversion layer m.i.s. solar cells. Y. W. Lam, M. A. Green, and L. W. Davies (New South Wales, University, Kensington, Australia). *Electronics Letters*, vol. 16, Aug. 28, 1980, p. 707, 708. Research supported by the Australian Research Grants Committee.

Inversion layer m.i.s. solar cells rely on the charge-inducing properties of antireflection (a.r.) coatings to achieve good device performance. It has previously been shown that these properties reduce with time due to build-up of an equilibrium charge density on the outside of the a.r. coating! Although devices can be designed to accommodate this, considerable relaxation in design constraints could be achieved if it were possible to develop techniques for preventing this effect. Results with a technique based on surfactants are described.

(Author)

A80-48177 # Computer simulation of solar panel voltage regulation. M. T. Gates and W. J. Muldoon (Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 106-109.

A computer simulation of voltage regulation of satellite solar panels by tapping the individual arrays of solar cells is described. The basic analysis strategy and its implementation are presented, then a sample problem is analyzed. A simple example satellite is used to show how the inputs to the simulator are found. Results for the individual taps and the total system are computed, and the outputs are presented as computer plots of satellite load current versus tap power dissipation and satellite bus voltage. (Author)

A80-48179 \* # Photocell heat engine solar power systems. R. T. Taussig, T. S. Vaidyanathan, S. Hoverson, C. Bruzzone (Mathematical Sciences Northwest, Inc., Bellevue, Wash.), and W. Christiansen (Washington, University, Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 119-124. 12 refs. Contract No. NAS2-10079.

A combined photocell heat engine concept is proposed for high efficiency solar energy conversion in space. In this concept the short wavelength portion of the solar spectrum is split by a dichroic filter and sent to a bank of photocells. The long wave-length remainder of the spectrum is used by the heat engine. This technique allows the photocells to operate with the minimum amount of waste heat,

increasing their efficiency and reducing the amount of cooling required. The heat engine operates by direct absorption in a working fluid containing broadband absorber molecules or particulates. A window in the heat engine admits the long wave-lengths from the solar spectrum. The window may also reflect a portion of the internal gaseous reradiation spectrum (e.g., a heat mirror) to help reduce radiation losses. Flow-induced thermal gradients may also reduce reradiation losses in the case of optically thick working fluids. The efficiencies computed for the photocell heat engine solar energy converter can be as high as 42 percent. (Author)

A80-48196 # Air/rock storage for solar central receiver power stations. W. B. Thomson, A. Z. Frangos, and T. H. Springer (Rockwell International Corp., Energy Systems Group, Canoga Park, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980. p. 254-258.

Studies have been performed of air-cooled rock bed storage systems incorporated in 100-MWe sodium-cooled solar central receiver power stations. Heat from a sodium-cooled receiver is transferred to the rock bed by means of sodium-to-air heat exchangers. The storage system can then deliver heat to the steam generators and turbine by transferring heat back through these same heat exchangers. The conceptual design of the storage system and results of thermocline analysis and the thermal cycling tests of rocks are presented. Air/rock storage has reasonably low costs at low storage capacities, while at large capacities it has a cost advantage over sodium and molten salt storage systems. The cost of a 48-h air/rock storage system is about \$3/kWhe. The value of large storage capacity is that power can be delivered during poor weather, solar energy can be stored even when the turbine is down, and the plant operations can be conducted in a more flexible manner. (Author)

A80-48198 # Solar retorting of oil shale. D. W. Gregg, J. Z. Grens, R. W. Taylor, and W. R. Aiman (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 262-267. 18 refs. Contract No. W-7405-eng 48.

An overview is presented on the applications of solar energy to the production of fuels. With respect to the use of solar energy as an aid in the production of fuels from fossil feedstocks, the four areas where the use of solar energy could have a major impact are: solar retorting of oil shale, solar coal gasification, solar steam flooding of oil fields, and solar steam reforming of methane. A detailed analysis of technical and economic factors is performed on only one of these, namely, solar retorting of oil shale. This analysis shows that such a process should be technically feasible and, depending on the grade of the shale, should improve the fuel yield from the oil shale by 10 to 40%, compared to one of the best competing surface processes. The improved oil yield should more than pay for the incremental cost associated with adding the solar collection system. An experiment is described in which solar energy is used to retort oil shale, and the experimental results show that yields of better than 110% Fischer Assay are achievable. An advanced design for a solar oil-shale retort is also discussed. (Author)

A80-48203 \* # GaAs solar cells for space applications. E. J. Conway, G. H. Walker (NASA, Langley Research Center, Hampton, Va.), and J. H. Heinbockel (Old Dominion University, Norfolk, Va.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy. Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 350-353. 7 refs.

GaAs solar cells offer substantial advantages for space photovoltaic power over Si solar cells in the areas of efficiency, elevated temperature operation, and radiation damage stability. A mission cost comparison is made for GaAs and Si solar cells. For Si cell arrays, the total mission cost is found to be a minimum for a solar concentration of 2.9. For GaAs, modes of operation and construction are investigated. Modes having lower mission costs than the minimum Si mission cost are defined. These include higher concentrations, lightweight cells, and simultaneous power generation and annealing. The technological progress necessary for GaAs to operate in these modes is identified. (Author)

A80-48204 \* # Effects of thermal annealing on the deep-level defects and I-V characteristics of 200 keV proton irradiated AIGaAs-GaAs solar cells. S. S. Li, D. W. Schoenfeld, T. T. Chiu (Florida, University, Gainesville, Fla.), and R. Y. Loo (Hughes Research Laboratories, Malibu, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 354-357. 11 refs. Grant No. NsG-1425.

Detailed characterization of deep-level defects and analysis of dark I-V data in 200 keV proton irradiated AlGaAs-GaAs solar cells have been carried out for several proton fluences (5 x 10 to the 11th, 10 to the 12th, and 10 to the 13th P/sq cm), using DLTS, C-V, and I-V measurement techniques. To study the effect of low temperature thermal annealing on the deep-level defect properties, these irradiated samples were annealed in vacuum at 300 C for one hour. Comparison was then made on the measured defect parameters (i.e., defect energy levels and densities) and the dark I-V characteristics for both the annealed and unannealed samples. (Author)

A80-48205 \* # The planar multijunction cell - A new solar cell for earth and space. J. C. Evans, Jr., A. T. Chai (NASA, Lewis Research Center, Cleveland, Ohio), and C. Goradia. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 358-363. 7 refs.

A new family of high-voltage solar cells, called the planar multijunction (PMJ) cell is being developed. The new cells combine the attractive features of planar cells with conventional or interdigitated back contacts and the vertical multijunction (VMJ) solar cell. The PMJ solar cell is internally divided into many voltage-generating regions, called unit cells, which are internally connected in series. The key to obtaining reasonable performance from this device was the separation of top surface field regions over each active unit cell area. Using existing solar cell fabricating methods, output voltages in excess of 20 volts per linear centimeter are possible. Analysis of the new device is complex, and numerous geometries are being studied which should provide substantial benefits in both normal sunlight usage as well as with concentrators.

(Author)

A80-48206 \* # The applicability of DOE solar cell and array technology to space power. J. A. Scott-Monck, P. M. Stella, and P. A. Berman (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 364-370. 34 refs. Contract No. NAS7-100.

Current trends in terrestrial photovoltaics that might benefit future space power needs are reviewed. Emphasis is placed on the Low-Cost Solar Array Project with attention given to the materials task, the silicon sheet task, the production processes and equipment task, and encapsulation. The Photovoltaic Concentrator Technology Development Project is also discussed. It is concluded that terrestrial photovoltaic technology that has either been developed to date or is currently under development will not have any significant effect on the performance or cost of solar cells and panels for space over the near term (1980-1990).

A80-48207 \* # High-efficiency. concentration/multi-solar-cell system for orbital power generation. J. R. Onffroy, D. E. Stoltzmann, R. J. H. Lin, and G. R. Knowles (Honeywell Systems and Research Center, Minneapolis, Minn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 371-376. 16 refs. Contract No. NAS8-33511.

An analysis was performed to determine the economic feasibility of a concentrating spectrophotovoltaic orbital electrical power generation system. In this system dichroic beam-splitting mirrors are used to divide the solar spectrum into several wavebands. Absorption of these wavebands by solar cells with matched energy bandgaps increases the cell efficiency while decreasing the amount of heat which must be rejected. The optical concentration is performed in two stages. The first concentration stage employs a Cassegrain-type telescope, resulting in a short system length. The output from this stage is directed to compound parabolic concentrators which comprise the second stage of concentration. Ideal efficiencies for one-, two-, three-; and four-cell systems were calculated under 1000 sun, AMO conditions, and optimum energy bands were determined. Realistic efficiencies were calculated for various combinations of Si, GaAs, Ge and GaP. Efficiencies of 32 to 33 percent were obtained with the multicell systems. The optimum system consists of an f/3.5 optical system, a beam splitter to divide the spectrum at 0.9 microns, and two solar cell arrays, GaAs and Si.

A80-48208 \* # Solar thermophotovoltaic space power system. W. E. Horne, A. C. Day, R. B. Greegor, L. D. Milliman (Boeing Aerospace Co., Seattle, Wash.), and W. L. Crabtree (NASA, Marshall Space Flight Center, Huntsville, Ala.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 377-382. 8 refs.

A study has been performed on the technical feasibility and cost of a TPV system for an alternative space power supply. An analysis of six previous studies has been performed and a consistent optical, thermal, and electrical model developed. A search of the literature for materials data has been augmented by an experimental test program on materials and breadboard subsystems of the TPV. These data have been used in the model to determine the technical feasibility and the degree of performance that might be expected from such a system. A system design study was then conducted to optimize the launch configuration, the weight, and the cost of the TPV space power system. Results from this study were used to define a specific design which could be used in a detailed cost analysis. A cost analysis was then performed to determine the relative costs of the TPV power system. It appears that a system having a specific power greater than 150 W/kg can be produced for approximately 30 dollars per watt. (Author)

A80-48209 # Concentrating photovoltaics - A viable candidate for the next, generation of Air Force satellite power systems. J. W. Geis (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 383-388. 9 refs.

The concentrating photovoltaic system offers the potential of providing kilowatts of electrical power at a reduction in power system cost while providing enhanced survivability to the natural and artificial space environments. One design under consideration is the Cassegrainian system. Sunlight is reflected off a spherical or parabolic concave primary mirror. A smaller convex mirror intercepts the light and directs it back toward the center of the primary mirror where there is positioned one solar cell. Depending on the precise configuration the flux incident on the solar cell can be magnified from 10 to 1000 times. A critical factor that will determine the

effectiveness and practicality, of the concentrating photovoltaic system is the ability to shield against various kinds of radiation and to reject thermal loads imposed by this radiation with a minimum increase in shielding weight and complexity.

(Author)

A80-48210 \* # Concentrator-enhanced photovoltaic arrays for deep space applications. D. E. Rockey (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 389-393. 8 refs. Contract No. NAS7-100.

The useful operational range of photovoltaic solar arrays has been limited to 1.5 AU (Mars orbit) due primarily to solar intensity constraints. Preliminary results indicate that the use of concentrator mirrors in conjunction with solar arrays can extend the practical operating range of photovoltaic space power sources to at least 9.5 AU (Saturn orbit). Various aspects of concentrator-enhanced photovoltaic arrays such as size, structure, thermal characteristics, intensity uniformity, pointing accuracy requirements, deployment methods, power performance and system mass are presented. Based on this information, concentrator-enhanced photovoltaic arrays are superior, with respect to power-to-mass and cost, to existing power sources used for deep space missions. The sensitivity of concentratorenhanced solar arrays to particulate radiation was also examined for representative deep space missions. Results are presented which show that a radiation-degraded, deep space, concentrator-enhanced solar array's performance exceeds that of existing RTG power sources.

(Author

A80-48211 \* # Heat-rejection design for large concentrating solar arrays. E. P. French (Rockwell International Corp., Space Operations and Satellite Systems Div., Seal Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 394-399. 9 refs. Contract No. NAS8-32988.

This paper considers the effect of heat rejection devices (radiators) on the performance and cost of large concentrating solar arrays for space application. Overall array characteristics are derived from the weight, cost, and performance of four major components; namely primary structure, optics/secondary structure, radiator, and solar panel. An ideal concentrator analysis is used to establish general cost and performance trends independent of specific array design. Both passive and heat-pipe radiation are evaluated, with an incremental cost-of-power approach used in the evaluation. Passive radiators are found to be more cost effective with silicon than with gallium arsenide (GaAs) arrays. Representative concentrating arrays have been evaluated for both near-term and advanced solar cell technology. Minimum cost of power is achieved at geometric concentration ratios in the range 2 to 6. (Author)

A80-48212 \* # Design and flight performance of the Pioneer Venus Multiprobe and Orbiter solar arrays. L. J. Goldhammer, J. B. Allan, and S. W. Gelb (Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 400-405. Contract No. NAS2-8300.

The designs of the solar arrays for the Pioneer Venus Orbiter and Multiprobe spacecraft are described, and the power output predicted for these arrays is compared with the in-space performance. The Orbiter solar array was designed to produce a minimum of 329 W at 28 V after 243 days in Venus orbit, except during eclipses and periapsis phases, when battery power was to be used. After 492 days in orbit, this solar array was producing 365.3 W at 29.6 V, exceeding its design objectives. The Multiprobe solar array produced sufficient power at low sun angles to effect the release of

the large probe and the three small probes and to power the scientific instruments onboard the spacecraft during its approach and destructive entry into the Venusian atmosphere.

A80-48213 # Insat-I solar array - Design and development summary. D. G. Peterson, D. C. Briggs, and N. Barberis (Ford Aerospace and Communications Corp., Western Development Laboratories, Palo Alto, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 406-409.

The Insat-I satellite is a three-axis stabilized spacecraft, designed to operate for seven years in a synchronous orbit. The function of the satellite is to provide communications and meteorological service to the country of India. The primary energy source is the single-axis; single tracking solar array wing. The solar torque produced by the single solar array wing is offset by a solar sail boom that extends opposite the solar array wing. The solar array is designed to provide 994 W divided between two separate power buses after seven years on-orbit. The solar array wing is composed of five graphite epoxy rigid deployable panels. The lightweight rigid structure represents a new development in solar array technology for synchronous orbit high power satellites. This paper describes the electrical and mechanical design of the Insat-I solar array. The results of the cell development tests are also included. These tests include radiation: testing, ultraviolet exposure tests, temperature characterization, and optical properties. (Author)

A80-48214 \* # Large area flexible solar array design for Space Shuttle application. C. J. Souza (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 410-414, Contract No. NAS9-15595.

A large area flexible solar array has been designed for Shuttle power augmentation. The solar array utilizes large area, low cost, weldable solar cells. The paper addresses how the unique requirements of this system are implemented into the design. Economic and reliability issues relating to the optimization of a large area, foldable solar array concomitant to the Shuttle/Orbiter system are reviewed.

(Author)

A80-48227 # The 100-kWp photovoltaic power system at Natural Bridges National Monument. F. J. Solman, J. H. Helfrich, E. F. Lyon, and A. E. Benoit (MIT, Lexington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

of Aeronautics and Astronautics, Inc., 1980, p. 511-514. 7 refs. Research sponsored by the U.S. Department of Energy.

The Natural Bridges National Monument in southeastern Utah is the location of the world's largest solar photovoltaic power system. This system, which operates in a stand-alone mode without utility backup, supplies from 300-400 kWh/day of 60-Hz ac electrical energy to the diversified loads in the monument headquarters area. A diesel-powered generator serves as backup for the system. The solutions to a number of problems encountered in the design, fabrication, testing and early operation of the system are discussed. (Author)

A80-48228 # Residential photovoltaic systems. E. C. Kern, Jr. (MIT, Lexington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 515-518. Research sponsored by the U.S. Department of Energy.

The status of the United States Department of Energy's Solar

Photovoltaic Residential Project is briefly reviewed with reference to the various systems under development and future development activities. The goal of the project is to develop residential photovoltaic systems which will be sold for \$1.60 per watt peak by 1986 (in 1980 dollars). An assessment of the feasibility of attaining the 1986 system price goal is presented. It is shown that the cost areas which require greatest attention are the power-conditioner design, array installation, and operation and maintenance. Comparison of the price goal and projected 1986 costs indicates that the goal; excluding the operation and maintenance costs, can be attained.

V.L.

A80-48229 # Residential photovoltaic systems costs. C. H. Cox, III (MIT, Lexington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 519-526. 18 refs. Research spon-

sored by the U.S. Department of Energy.

A study of costs associated with the installation and operation of a residential photovoltaic system has been conducted to determine present and projected (1986) status. As a basis for the study, a residential photovoltaic system design projected for 1986 was assumed, consisting of two principal components: a roof-mounted array and a utility-interactive inverter. The scope of the study encompassed both new and retrofit residential applications employing both silicon and cadmium sulfide photovoltaic modules. Cost estimates were obtained by a survey and study of reports generated by companies and agencies presently active in each of the subsystem areas. Where necessary, supplemental estimates were established as part of this study. The range of estimates for silicon-based systems strongly, suggest that such systems will be competitive for new installations and reasonably competitive for retrofit applications. The cadmium-sulfide-based system cost estimates, which are less certain than those for silicon, indicate that these systems will be marginally competitive with silicon-based systems for new construction, but not competitive for retrofit applications. Significant variations from the DOE system price subgoals were found, however, particularly in the areas of array mounting, wiring and cleaning. Additional development work appears needed in these areas.

A80-48230 # Intermediate load-center photovoltaic application experiments. E. L. Burgess (Sandia Laboratories, Albuquerque, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 527-531. Research supported by the U.S. Department of Energy.

A total of nine intermediate load-center photovoltaic systems were carried into the construction phase this year. These nine systems range in size from 20 to 225 kWp electrical output and total almost 1 MWp. They are being installed in a diverse set of applications and locations and represent the bulk of the photovoltaic initial system evaluation experiments for the intermediate load-center sector. Each of these experiments is briefly described and the status of the construction phase is given for each project. (Author)

A80-48231 # Photovoltaic central station applications - Status and prospects. G. J. Jones (Sandia Laboratories, Albuquerque, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 532-536. 18 refs. Research supported by the U.S. Department of Energy.

This paper discusses the current planning and data within the Department of Energy's National Photovoltaic Program relating to photovoltaic central station applications. The projected role of these plants is described and the sensitivity of future utilization as a

function of alternate energy costs are briefly reviewed. Utility applications will place specific and unique technical and engineering requirements on hardware development activities and these are indicated. The issues which must be addressed before utility acceptance of these plants can be expected are identified and the time and funding requirements indicated. (Author)

A80-48232 # 470-kW photovoltaic power system for Saudi Arabia villages. M. S. Imamura, R. L. Moser, J. A. Sanders, S. Broadbent (Martin Marietta Aerospace, Denver, Colo.), F. Huraib, and B. Khoshaim (Solar Energy Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, 1nc., 1980, p. 537-541. Research sponsored by the U.S. Department of Energy, Solar Energy Research Institute, and Saudi Arabia National Center for Science and Technology.

A80-48233 # High performance photovoltaic systems. H. J. R. Maget (Varian Associates, Inc., Palo Alto, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference; Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 542-549. 7 refs.

Photovoltaic systems generating electric power and thermal energy can operate at high efficiency if the thermal energy is generated at temperatures compatible with the operation of organic Rankine cycle engines. GaAs solar cells are well suited for such systems, since the cell can operate at relatively high functional temperatures without considerable performance degradation. System efficiencies in excess of 20% are predicted based on the use of an efficient 'stagnation point' solar cell cooling concept. (Author)

A80-48243 # Solar coal gasification. D. W. Gregg, R. W. Taylor, J. H. Campbell, and W. R. Aiman (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference. Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 633-636. 6 refs. Contract No. W-7405-eng-48.

Subbituminous coal was gasified with steam using direct solar irradiation in a 25kW solar furnace. The sunlight was focused directly on the coal bed being gasified through a window in the reactor. Steam (with no oxygen) was passed through the solar-heated coal bed where it reacted with the coal and thus formed a combustible product gas that contained the energy content of both the coal and the sunlight. More than 40% of the sunlight arriving at the focus external to the reactor was chemically stored as fuel value in the product gas. The product-gas production rate increased with increased solar power, and the product-gas composition and thus heating value were almost independent of solar power. A typical moisture-free gas composition was 54% H2, 25% CO, 16% CO2, 4% CH4, and 1% higher hydrocarbons. (Author)

A80-48262 # A six kilowatt transformer-coupled converter for Space Shuttle solar power systems. M. C. Glass (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 767-772.

A multi-kilowatt transformer-coupled power converter has been developed by Lockheed Missiles and Space Company, Inc., for conversion of higher voltage solar array power from 120 to 330 volts to regulated 32 volts dc. This power converter meets the weight and efficiency goals required for space applications, through the use of transistor bridge conversion and high frequency transformer coupling. The specific intended application of the transformer-coupled converter is the Space Shuttle Power Extension Package solar array

power system, which deploys a 30 kWe solar array from the Shuttle Orbiter for extended duration Space Shuttle Missions. (Author)

A80-48286 # Solar/electric district heating via CASES. W. R. Powell (Johns Hopkins University, Laurel, Md.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 904-909. Research sponsored by the U.S. Department of Energy and U.S. Navy.

A district heating and cooling system using solar energy and surplus heat from large community buildings is described. The Community Annual Storage Energy System (CASES) is based on water-source heat pumps, warm and cold water pipelines, and seasonal storage of thermal energy. CASES is designed for a warmer climate, where cooling demands cannot be ignored. The system is compatible with existing American regulatory institutions and the historic utility goal of generating electric power with the highest possible efficiency. CASES offers economic means for both diurnal load management and seasonal transfer of electric power demands.

(Author)

A80-48287. # Sensitivity analysis of the value of a solar driven chemical heat pump system. W. R. L. Thomas (Exxon Advanced Energy Systems Laboratory, Linden, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 921-925.

A new technique is devised to make quantitative estimates of the value of the three major components of a solar driven chemical heat pump, i.e., the solar collector, the thermodynamic machine used to pump heat or cool (the chemical heat pump), and storage (assumed to be chemical). The analysis is based on the results of a TRNSYS simulation of a chemical heat pump system in a New York climate. For a typical system, the analysis indicates that the chemical heat pump is worth about half the total system value. The solar collectors represent about one-third the system value, and the remaining one-sixth system value is associated with storage. The results also confirm the importance of an all-year system capable of both winter heating and summer cooling. A formal approach based on differential analysis is developed to help indicate the most fruitful avenue to a higher value system. It is shown that the coefficient of performance is the most important parameter. (Author)

A80-48289 # Engineering prototype studies on the CaCl2-CH3OH chemical heat pump for solar air conditioning, heating, and storage. P. O. Offenhartz, D. Schwartz, R. E. Malsberger, and T. V. Rye (EIC Corp., Newton, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 932-935. 5 refs. Research supported by the U.S. Department of Energy.

A80-48308 # Electrical power subsystem for INSAT-I. D. C. Briggs and H. N. McKinney (Ford Aerospace and Communications Corp., Palo Alto, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1058-1063.

The INSAT-I electrical power subsystem is designed to support an average continuous sunlight electrical power load of approximately 940 W and an eclipse load of approximately 343 W for a 7-year geosynchronous orbit lifetime. This paper describes the design and integration concepts of the INSAT power subsystem including the rationale leading to the selected configuration. Attention is also given to the implementation details of the power subsystem elements and to the relationship of this power subsystem with other Ford Aerospace spacecraft designs.

A80-48309 # Electrical power system for the SBS communication satellite. M. W. Miller (Hughes Aircraft Co., Space and Communications Group, El Segundo, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1064-1069.

The SBS electrical power system uses advanced technology to satisfy the spacecraft power requirements over the mission life. The system includes solar panels, batteries, and power control electronics in a dual and independent balanced bus configuration. This paper examines the spacecraft power requirements and gives a description of the power system.

B.J.

A80:48353 \* # The SPS concept - An overview of status and outlook. F. C. Schwenk (NASA, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1375-1381. 10 refs.

The satellite power system (SPS) concept has been reviewed and assessed in a concept development and evaluation program. This paper presents the results of the assessment in systems definition, environmental factors, social impacts, and comparison of future energy systems. Although no insurmountable objections to SPS have been identified, there remain issues that can be resolved only through further research.

B.J.

A80-48354 # Potential economics of large space based solar power stations. O. E. Johnson (Boeing Aerospace Co., Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1384-1389.

The predicted economics of a solar power satellite are compared to those of future conventional power plants (coal fired or nuclear). It is found that transmission of solar power from space is potentially an economic energy alternative for the United States. The details of the comparison are presented.

B.J.

A80-48355 \* # Multi-hundred kW solar arrays for space. W. G. Woodcock, III and J. A. Mann (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1390-1395. Contract No. NAS8-32981.

A system-level approach has been applied in designing a cost-effective 300-1000 kW solar array for Low Earth Orbit (LEO) application with a mission time frame of mid-1980's. Technology investigations and performance and cost prognoses in the area of solar cells and reflector material form a key influence on array design and performance. Major tradeoffs were conducted between planar and concentrator concepts and between silicon and GaAs solar cells. Three baseline design concepts emerged: planar, low-CR concentrator (CR = 5), and high-CR concentrator (CR = 125). Combinations of these concepts with silicon and GaAs solar cells were analyzed in terms of electrical performance, thermal behavior, structural configuration, weight, stowed and deployed volume, and installation/ deployment method. To identify the most cost-effective designs, a cost analysis of the candidate arrays was performed. The low-CR/GaAs array and the planar/silicon array demonstrate the greatest cost-effectiveness of the candidate arrays in terms of dollars/watt and energy life-cycle cost. Due to the high uncertainty of GaAs cell-cost prognoses, the sensitivity of the results to the GaAs cell cost is discussed. (Author)

A80-48356 \* # Design, performance and life cycle cost relationships for a 500kW space solar array. P. W. Richardson, F. Q.

Miller, and M. N. White (PRC Systems Services Co., Huntsville, Ala.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1396-1400. Contract No. NAS3-21926.

The effects on life cycle costs of a number of technology areas are examined for a LEO, 500kW space solar array. A baseline system conceptual design is developed and the life cycle costs estimated in detail. The baseline system requirements and design technologies are then varied and their relationships to life cycle costs quantified. For example, the thermal characteristics of the baseline design are determined by the array materials and masses. The thermal characteristics in turn determine configuration, performance and hence life cycle cost. (Author)

A80-48362 \* # Salton Sea solar pond project. R. L. French (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) and I. Meitlis (Southern California Edison Co., Rosemead, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1430, 1431. Research sponsored by the U.S. Department of Energy.

The feasibility of constructing salt gradient solar ponds within the Salton Sea is being studied. These ponds would serve a dual purpose: (1) become a depository for unwanted salt and (2) supply thermal energy for driving turbine electric power systems. Under present circumstances, the rise in salinity is expected to eliminate fish life and create other unfavorable conditions. The proposed concept would have a power generation potential of 600 MWe.

(Author)

A80-48363 # Management of a large, operational solar pond.
L. J. Wittenberg and M. J. Harris (Monsanto Research Corp., Mound Facility, Miamisburg, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 1435-1437. Contract No. DE-ACO4-76DP-00053.

Routine and nonroutine maintenance is discussed based on experience with the largest operational solar pond in the United States, the one in Miamisburg, Ohio. The routine maintenance of a solar pond, such as algae control and water clarity control, is minimal; and the upkeep expense associated with this maintenance is small. Nonroutine maintenance, however, can be very involved as well as expensive. Attention is given to such nonroutine problems as the corrosion of the heat exchanger and a leak in the containment system.

B.J.

A80-48364 # Key questions in the application of saltstratified solar ponds. R. F. Boehm and T. Newell (Utah, University, Salt Lake City, Utah). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1438-1443. 14 refs.

Three crucial questions are asked regarding the application of large-scale salt-stratified solar ponds: (1) what is the potential energy output of ponds in any specific location, (2) what techniques are best applied for harvesting energy and generating power, and (3) can analytical methods be applied successfully to predict the formation and long-term behavior of the convective zones. Partial answers to these questions are presented with reference to work being done on the Great Salt Lake.

B.J.

A80-48365 # Operational experience with a saturated borax solar pond. T. L. Ochs (Nevada, University, Reno, Nev.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy

Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1444-1447. 8 refs. Contract No. DE-AS04-79CS-30174-501.

For many years there has been speculation on the potential advantages that saturated or partially saturated solar ponds might have over conventional non-convecting salt gradient ponds. Some of these expected advantages are reduced maintenance and lower fresh water usage. Actual operation of the DRI saturated borax pond has confirmed some of these expected advantages as well as revealing certain operational problems. This paper will address four of these problem areas: (1) dimensional considerations in a small size pond, (2) contamination, (3) cover techniques, and (4) bottom reflectance.

A80-48366 # Laboratory demonstration of self-creation, self-maintenance and self-correction of saturated solar ponds. S. C. Jain and G. D. Mehta (InterTechnology/Solar Corp., Warrenton, Va.). In: Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1448-1452. 12 refs.

A80-48367 # Solar ponds for district heating and electricity generation. C. M. Leboeuf, J. S. Kowalik, M. Edesess, and T. S. Jayadev (Solar Energy Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1453-1458. 12 refs.

This paper considers system requirements, performance, and costs for the application of solar ponds to district heating and to electricity generation. It focuses on the optimal sizing and configuration of the solar ponds themselves, but other system features are also investigated and discussed. Performance and costs range widely, depending upon location and component costs, particularly upon salt costs for the salt gradient pond. Distribution cost for district heating is also an important parameter that can vary widely. Both salt gradient and saltless ponds are considered. (Author)

A80-48417 \* # The JPL parabolic dish project. V. C. Truscello and A. N. Williams (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 1741-1746. Research sponsored by the U.S. Department of Energy and NASA.

The parabolic dish solar collector is a highly versatile concentrating collector system that can produce heat for many thermal processes and electricity by coupling the collector to a suitable heat engine. This paper discusses a project for the development of these collector systems and summarizes contracts with industry for developing the dish subsystems which include concentrator, receiver, and heat engine. An early market for dishes is the dispersed small community market which depends heavily on oil to operate diesel or steam turbine plants in order to generate electricity. The present contracts with industry for conducting engineering experiments using the developed dish hardware to demonstrate the technology in these early opportunity markets is also discussed. (Author)

A80-48418 \* # Comparison of advanced engines for parabolic dish solar thermal power plants. T. Fujita, J. M. Bowyer, and B. C. Gajanana (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1747-1752. 14 refs. Research sponsored by the U.S. Department of Energy and NASA.

. A paraboloidal dish solar thermal power plant produces electrical energy by a two-step conversion process. The collector subsystem is composed of a two-axis tracking paraboloidal concentrator and a cavity receiver. The concentrator focuses intercepted sunlight (direct, normal insolation) into a cavity receiver whose aperture encircles the focal point of the concentrator. At the internal wall of the receiver the electromagnetic radiation is converted to thermal energy. A heat engine/generator assembly then converts the thermal energy captured by the receiver to electricity. Developmental activity has been concentrated on small power modules which employ 11- to 12-meter diameter dishes to generate nominal power levels of approximately 20 kWe. A comparison of advanced heat engines for the dish power module is presented in terms of the performance potential of each engine with its requirements for advanced technology development. Three advanced engine possibilities are the Brayton (gas turbine), Brayton/Rankine combined cycle, and Stirling engines.

A80-48419 • # Thermal buffering of receivers for parabolic dish solar thermal power plants. R. Manvi, T. Fujita, B. C. Gajanana, and C. J. Marcus (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 1753-1759. 5 refs. Research sponsored by the U.S. Department of Energy and NASA.

A parabolic dish solar thermal power plant comprises a field of parabolic dish power modules where each module is composed of a two-axis tracking parabolic dish concentrator which reflects sunlight (insolation) into the aperture of a cavity receiver at the focal point of the dish. The heat generated by the solar flux entering the receiver is removed by a heat transfer fluid. In the dish power module, this heat is used to drive a small heat engine/generator assembly which is directly connected to the cavity receiver at the focal point. A computer analysis is performed to assess the thermal buffering characteristics of receivers containing sensible and latent heat thermal energy storage. Parametric variations of the thermal inertia of the integrated receiver-buffer storage systems coupled with different fluid flow rate control strategies are carried out to delineate the effect of buffer storage, the transient response of the receiverstorage systems and corresponding fluid outlet temperature. It is concluded that addition of phase change buffer storage will substantially improve system operational characteristics during periods of rapidly fluctuating insolation due to cloud passage. (Author)

A80-48462 # Comparative economics of small solar thermal electric power systems. T. A. Williams (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics Inc., 1980; p. 2019-2025. 7 refs. Contract No.

DE-AC06-76RL-01830.

Initial capital investment costs of small solar thermal electric power systems are compared. Capital investment costs for 5 MWe plants at 0.4 capacity factor were found to range from approximately \$2000-\$3000/kW for the ten concepts analyzed. Capital investment costs show a marked sensitivity to plant capacity factor and power level that varies substantially among the concepts, showing that a comparision of concepts for a specific plant will not necessarily be valid at other capacity factors or power levels. In general, capital investment costs achieved by point focus concepts were lower than those achieved by line focus and nontracking concepts. (Author)

A80-48463 # Assessment of solar thermal concepts for small power systems applications. W. W. Laity, D. T. Aase, W. J. Apley, S. P. Bird, J. W. Currie, M. K. Drost, and T. A. Williams (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conver-

sion Engineering Conference, Seattle, Wash., August 18-22, 1980.

Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 2026-2033. 9 refs. Contract No. DE-AC06-76RL-01830.

The paper discusses a comparative analysis of ten solar thermal conversion concepts that are potentially suitable for development as small electric power systems (1-10 MWe). Seven generic types of collectors, together with associated subsystems for electric power generation, were considered. All seven collectors were analyzed in conceptual systems with Rankine-cycle engines. In addition, two of the collectors with particularly high concentration ratios were analyzed with Brayton-cycle engines, and one of the two also was analyzed with Stirling-cycle engines. Year-long simulations were performed with the PNL computer code SOLSTEP to determine the thermodynamic performance characteristics and energy costs of the conceptual systems. Multiattribute utility methodology was used to rank the concepts. The point focus central receiver concept with Rankine power conversion and the point focus distributed receiver concept with Brayton or Stirling power conversion consistently ranked high relative to the other concepts. The line focus distributed receiver concept with a tracking receiver and the line focus central receiver concept (both with Rankine power conversion) consistently ranked low relative to the others.

A80-48464 # One megawatt /thermal/ bench model solar receiver design and test. W. D. Beverly (Boeing Engineering and Construction Co., Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 2034-2038.

A one megawatt (thermal), high temperature, gas cooled solar central receiver has been designed and tested. The test purpose was to demonstrate the flow and temperature control functions of a solar thermal conversion system but without generating power. The cavity receiver design featured a north-facing downward inclined aperture. Solar tests were planned to evaluate receiver performance under controlled conditions and in a natural, solar-load-following scenario. Controlled tests included equilibrium heat balance, non-uniform cavity heating, restricted coolant flow and thermal transients. Solar following tests were emergency cooldown, rapid startup and full day operation. All program objectives were achieved. Outlet gas temperatures of 816 C (1500 F) were obtained on automatic flow control for significant periods of time. Heat exchanger tubing attained 927 C (1700 F) with no evidence of deterioration. Thermal conversion efficiency of 75% at design point, as predicted, was accomplished. Thermal inputs 10% in excess of design point were accommodated. (Author)

A80-48465 \* # Power processing and control requirements of dispersed solar thermal electric generation systems. R. L. Das (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc.,

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2039-2044. 7 refs.

Power Processing and Control requirements of Dispersed Receiver Solar Thermal Electric Generation Systems are presented. Kinematic Stirling Engines, Brayton Engines and Rankine Engines are considered as prime movers. Various types of generators are considered for ac and dc link generations. It is found that ac-ac Power Conversion is not suitable for implementation at this time. It is also found that ac-dc-ac Power Conversion with a large central inverter is more efficient than ac-dc-ac Power Conversion using small dispersed inverters. Ac-link solar thermal electric plants face potential stability and synchronization problems. Research and development efforts are needed in improving component performance characteristics and generation efficiency to make Solar Thermal Electric Generation economically attractive.

(Author)

A80-48466 # Ceramic dome receiver technology developments. P. O. Jarvinen (MIT, Lexington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2045-2050. 7 refs. Research sponsored by the U.S. Department of Energy.

The development and experimental demonstration of a high-temperature seal for the SHARE ceramic dome cavity receiver is reported. The mechanical contact seal which was tested on one-foot-diameter silicon-carbide ceramic-dome hardware at pressure differentials to four atmospheres and dome temperatures to 2200 F (1200 C) showed negligible leakage at expected receiver operating conditions. Potential solar receiver applications for the technology are illustrated. (Author)

A80-48467 # An advanced 15 kW solar powered free-piston Stirling engine. G. Benson, W. Rifkin, and R. Vincent (ERG, Inc., Oakland, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc.,

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2051-2056. 11 refs.

The operating theory and design of an advanced 23-kWe free-piston Stirling engine alternator of single and three phase output are described. This hermetically sealed, fully balanced unit with ceramic hot components has a predicted efficiency of nearly 70%, a lifetime of 200,000 hours, a weight of about 60 kg, and an estimated plant cost of \$60/kWe. Combining this unit with an advanced concentrator reduces the concentrator area by a factor of 2.5 relative to the best first generation dish-Stirling technology. Coupling this system to a high-temperature electrolysis unit would produce hydrogen at an efficiency of 80-90% of solar energy collected. B.J.

A80-48480 # Test evaluation of a prototype 18-ton solar powered heating and cooling system. G. Melikian, F. R. Biancardi, and M. D. Meader (United Technologies Research Center, East Hartford, Conn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2127-2130. 5 refs.

UTC has built and tested an 18-ton cooling capacity, 500,000 Btu/hr solar heat pump over a wide range of operating conditions simulating an actual building installation. Operation in both the cooling and heat pump mode was demonstrated at selected building, climatic, and collector/storage conditions. The design point performance of the heat pump in both the cooling and heat pump modes was confirmed. Operation and control were routine and transient response was rapid. Air-cooled operation at industry standard rating conditions was demonstrated as well as such design features as wide operating range and high heat pump performance.

B.J.

A80-48507 # A comparison of the flat plate and concentrating solar collector. R. P. Stromberg (Sandia Laboratories, Albuquerque, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2301-2305. 6 refs.

The flat plate collector is the most common choice for residential hot water applications. This paper compares a trough concentrating collector of simplified design with the flat plate collector, and it is shown that the performance of parabolic trough collectors is now competitive for residential hot water systems, even in cloudy climates. Thus, it is no longer clear that the flat plate collector is an obvious choice for residential hot water.

B.J.

A80-48513 # Thin film solar cells. A. M. Barnett (Delaware, University, Newark, Del.). In: Energy to the 21st century; Proceed-

ings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2342-2349, 27 refs.

The development and deployment of low-cost thin-film solar cells for the direct conversion of sunlight to electricity can be accelerated by the utilization of loss minimization and cost minimization methodologies. At present there are more than sixteen different material systems being actively investigated for potential low cost thin film solar cells. A systematic procedure is described herein to analyze the potential of each of these materials for energy conversion efficiency. The solar cell is separated into its five constitutent layers to provide a common basis for the development of these methodologies. Photovoltaic theory, materials science and loss analysis are combined to develop the loss minimization methodology which can be used to systematically improve and optimize performance of any solar cell material system. The techniques of the chemical process industry have been applied to achieve cost minimization. The loss and cost minimization methodologies have been combined into a generalized procedure for an analysis of the potential of all low-cost thin-film photovoltaic material systems. (Author)

A80-48548 Photo-intercalation - Possible application in iolar energy devices. H. Tributsch (CNRS, Laboratoire d'Electrochimie Interfaciale, Meudon, Hauts-de-Seine, France). Applied Physics, vol. 23, Sept. 1980, p. 61-71. 33 refs.

Theoretical considerations and preliminary electrochemical experiments with ZrSe2 indicate the possibility of onverting and simultaneously storing solar energy by means of light driven electrochemical reactions producing intercalation compounds of layer-type semiconducting material. A precondition is that the ntercalated compound maintains a semiconducting behavior and hat its ionic properties complement in a favourable way. Promising ubstrates were identified in p-type zirconium- and hafniumfichalcogenides, but also TiS2 would be useful if it could be made -conducting. Solar cells based on photo-intercalation - if they could be developed for practical use - would not only be simple, but also nore convenient to use in irregular sunlight than conventional devices. Some thermodynamic properties and attainable efficiencies of this new type of solar cell are discussed as well as difficulties which would have to be surmounted. (Author)

A80-48789 Current status of growth processes for solar grade silicon. S. Pizzini (Montedison S.p.A., Novara, Italy). Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique, 1st Semester, 1980, p. 8-13. 24 refs.

The solar cells which are currently available on the market are made with electronic silicon single crystal slices, although recently polycrystalline silicon solar cells are produced by several manufacturers. As the key factor for the penetration of the photovoltaic conversion in the energy market is the price of solar cells, attempts to reduce the cost of this device by reducing the cost of the material are carried out worldwide. Aim of this paper is to examine critically the current status of the 'solar' silicon technology, with major emphasis on emerging materials and on the single crystal or polycrystalline ribbon technology. (Author)

A80-48790 Photovoltaic conversion - Recent progress in solid state solar cells. R. Kaplow (MIT, Cambridge, Mass.). Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique, 1st Semester, 1980, p. 14-21. 26 refs. Research sponsored by the National Patent Development Corp. and Massachusetts Institute of Technology.

Recent advances in solar cell technology are examined. Three types of cells are discussed: (1) silicon single-crystal etched multiple vertical junction cells useful for high intensity (high concentration) applications, (2) silicon thin-film polycrystalline horizontal junction cells, and (3) silicon thin film glassy horizontal junction cells. Problems of cell cost are considered.

A80-48791 Daily irradiations measured on three photovoltaic systems in Toulouse (Irradiations quotidiennes et mesurées sur trois dispositifs photovoltaiques à Toulouse). C. Delorme (Compiègne, Université de Technologie, Compiègne, France). Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Heliotechnique, 1st Semester, 1980, p. 22-25. In French.

A method for calculating the diffuse and direct components of solar radiation from meteorological data (insolation, cloudiness, vapor pressure, etc.) is presented. Calculated results are compared with insolation data for three photovoltaic systems in Toulouse. It is concluded that the calculation method is useful for the simulation of the operating conditions of photovoltaic systems.

B.J.

A80-48792 Heating requirements and estimations of solar energy available in tran. J. Maghsood (Teheran University, Karaj, Iran). Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique, 1st Semester, 1980, p. 26-29. 12 refs

In this paper heating requirements of 42 sites of Iran is obtained through heating-degree-day values. Using meteorological data such as sunshine hours, relative humidity, and maximum temperature of 39 stations for 15 years, the total and diffuse solar radiations on a horizontal surface for cold and warm half years is estimated. Maps of these values plus yearly sunshine hours are presented. The locations requiring no heating year around or during few months and those with the maximum heating requirements are recognized. Isolines of total and diffuse solar radiations on a horizontal surface are also given. These estimates are compared with those of others and with the available data. (Author)

A80-48793 The effect of direct and diffuse radiations on the thermal performance of flat-plate solar collectors (Influence des rayonnements direct et diffus sur les performances thermiques des capteurs solaires plans). J.-M. Caillat and E. Moine (Laboratoire d'Héliothermie, Lavéra, Bouches-du-Rhône, France). Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique, 1st Semester, 1980, p. 30-36.7 refs. In French.

The thermal performances of two flat plate solar collectors with two different covers according to the ratio of diffuse to direct radiation. A theoretical approach has been developed and verified in order to estimate diffuse solar energy from global energy measurements. (Author)

A80-48794 The optimal interconnection of solar collectors in air heating systems with large collector surfaces (Sur l'interconnexion optimale des insolateurs dans les systèmes de chauffage de l'air avec de grandes surfaces de captation). V. Badescu and C. Oancea (Bucuresti, Institutul Politehnic, Bucharest, Rumania). Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique, 1st Semester, 1980, p. 37-41. In French.

A80-48795 Solar energy utilization in a collective habitat The Fribourg Solar House in Brisgau (Utilisation de l'énergie solaire dans l'habitat collectif - La Maison Solaire de Fribourg en Brisgau). K. Vanoli (IST Energietechnik GmbH, Kandern, West Germany). Coopération Méditerranéenne pour l'Energie Solaire, Revue Internationale d'Héliotechnique, 1st Semestre, 1980, p. 47-49. In French. Research supported by the Bundesministerium für Forschung und Technologie.

A80-48916 Solar thermal electric power systems in Japan. T. Tanaka (Ministry of International Trade and Industry, Electrotechnical Laboratory, Sakura, Ibaraki, Japan). Solar Energy, vol. 25, no. 2, 1980, p. 97-104. 8 refs.

The paper outlines the recent basic research and technical development for solar thermal electric power systems in Japan. Solar thermal electric power systems are presently being developed as one of the most important systems in the Sunshine Projects which were initiated in 1974 to develop utilization systems of new energy resources. Conceptual designs of solar thermal power systems have

been done on the basis of the results of the supporting research and two pilot plants of solar thermal electric power systems of a capacity of 1000 kWe are under construction on the basis of the conceptual and detailed designs and are to be constructed by 1981. The present conditions of these pilot plants and the major research which is thought to be the most important subjects in basic research and technical developments for solar thermal electric power systems are described.

(Author)

A80-48917 Similarity theory of solar water heater with natural circulation. B. J. Huang (National Taiwan University, Taipei, Nationalist China). Solar Energy, vol. 25, no. 2, 1980, p. 105-116. 8 refs. Research supported by the Aiteh Engineering Co.

The similarity theory of solar thermosyphon collector is developed in the present paper. Ten dimensionless groups or system characteristic parameters which uniquely determine the performance of the collector are derived. The solution shows that the mean efficiency generally increases with increasing incident solar radiation and relative height of the tank. For the frictional parameters N(e) and N(f) higher than 100,000, the efficiency appears to be independent of the incident radiation and the relative height of the tank. Therefore, for parallel plate absorber, the tank may be designed to sit on the floor without sacrificing the efficiency since the values of N(e) and N(f) are usually larger than 100,000 in most designs.

(Author)

A80-48919 A theoretical study of the modelling and control of a solar water electrolysis plant. P. Vandergeest and T. Z. Fahidy (Waterloo, University, Waterloo, Ontario, Canada). Solar Energy, vol. 25, no. 2, 1980, p. 123-129. 11 refs.

A control-oriented model is presented for a hydrogen producing plant consisting of a conventional water electrolysis process, and a photo-assisted water electrolytic installation which utilizes solar energy via a suitable semiconductor/electrolyte assembly. A control strategy for daily hydrogen production is illustrated by a numerical example. The proposed simulation of solar water electrolysis plants is of potential usefulness for automatic control of the photoelectrolytic process when combined with statistical data-logging and model updating carried out in a practical installation.

A80-48921 A stochastic model for predicting solar system performance. A. A. Sfeir. Solar Energy, vol. 25, no. 2, 1980, p. 149-154. 11 refs. Research supported by the American University of Beirut, Ecole Nationale des Travaux Publics de l'Etat, and Council for Scientific Research of Lebanon.

A method for predicting long term performance of solar systems is presented. The method uses a stochastic approach and is based on some statistical properties of monthly averages of daily insolation and dry bulb temperatures. Application of this method to solar heating and hot water systems yields results that agree with those obtained using the f-chart and with experimental observations.

(Author)

A80-48922 A design method for parallel solar-heat pump systems. J. V. Anderson, J. W. Mitchell, and W. A. Beckman (Wisconsin, University, Madison, Wis.). Solar Energy, vol. 25, no. 2, 1980, p. 155-163. 23 refs. Contract Nó. EY-76-S-02-2588-A002.

In this paper, a method is developed for predicting the performance of parallel solar-heat pump systems. This procedure requires as inputs the fraction of the space and water heating load met by solar energy, and the fraction of the load that would have been met by the same heat pump operating without a solar system (a stand-alone system). The procedure then combines these results in a way which accounts for the interaction of the solar system and the heat pump and yields the performance of the combined system. The purchased energy fractions determined from this procedure are compared to those from detailed simulations. The standard deviation of the prediction errors are within 1.3 per cent of the load, and within the accuracy with which system parameters are known.

(Author)

A80-48923 Photoreduction of carbon dioxide and water into formaldehyde and methanol on semiconductor materials. B. Aurian-Blajeni, M. Halmann, and J. Manassen (Weizmann Institute of Science, Rehovot, Israel). Solar Energy, vol. 25, no. 2, 1980, p. 165-170. 20 refs. Research supported by the Ministry of Energy and Infrastructure, National Council for Research and Development, and Kernforschungsanlage Jülich GmbH.

Heterogeneous photoassisted reduction of aqueous carbon dioxide was achieved using semiconductor powders, with either highpressure Hg-lamps or sunlight as energy sources. The products were methanol, formaldehyde and methane. The reaction was carried out either as a gas-solid process, by passing carbon dioxide and water vapor over illuminated semiconductor surfaces, or as a liquid-solid reaction, by illuminating aqueous suspensions of semiconductor powders through which carbon dioxide was bubbled. Best results, under illumination by Hg-lamps, were obtained with aqueous suspensions of strontium titanate, SrTiO3, tungsten oxide, WO3, and titanium oxide, TiO2, resulting in absorbed energy conversion efficiencies of 6, 5.9 and 1.2 per cent, respectively. (Author)

A80-48924 High temperature solar energy conversion systems. K. M. Price (Stanford University, Stanford, Calif.). Solar Energy, vol. 25, no. 2, 1980, p. 187-189. 13 refs. Research supported by Stanford University and Electric Power Research Institute:

The fractional efficiency P and the flux density parameter Q are identified for a high-concentration solar energy system which consists of an optical subsystem (concentrator) and a convertor. A relationship is established between these two parameters which can be used to clarify the interaction between the conversion efficiency, the converter temperature, parameters of the optical subsystem, and parameters of the converter entrance. The results are displayed on one universal diagram. A region of maximum efficiency is deduced which is applicable to the whole range of this type of high-concentration system. A design formula for optimum converter temperature is derived.

A80-48947 An emissometer with high accuracy for determination of the total hemispherical emittance of surfaces. W. W. Beens, M. Sikkens, and J. L. Verster (Groningen, Rijksuniversiteit, Groningen, Netherlands). Journal of Physics E - Scientific Instruments, vol. 13, Aug. 1980, p. 873-876. 6 refs.

A calorimetric emissometer is presented which is designed for measuring the total hemispherical emittance of solar spectral-selective absorbers in the temperature range 30-160 C. An electrically heated specimen is placed opposite a black receiver surface cooled by liquid nitrogen. When thermal equilibrium is reached, the radiated heat flux from the specimen to the receiver almost equals the supplied electrical power. A small fraction of the power which is lost due to leakage is accurately calibrated. Errors in the emittance due to imperfect correction of the heat loss through the gap are negligible when the gap is small (usually D = 0.35 mm) and the cover emittance is high. The reproducibility of the instrument is usually within 0.002, even when the specimen is removed and installed again.

V.L.

A80-49322 Optimized grid patterns for Cu2S-CdS solar cells. B. Jacobs, G. De Mey, and K. Stevens (Gent, Rijksuniversiteit, Ghent, Belgium). International Journal of Electronics, vol. 48, May 1980, p. 397-402.

The influence of the sheet resistance on the curve factor has been calculated for thin film Cu2S-CdS solar cells. The calculations are performed for different values of the sheet resistivity and applied to cells having an area of  $4 \times 1.7$  sq cm. Using a grid with n1 fingers in one direction and n2 fingers in the other direction, the curve factor has been calculated for n1 and n2 ranging from 1 to 40 or grid spacings up to 625 microns. For the top contacts widths of 25 microns, 100 microns, and 300 microns were considered. It was found that the best curve factor was obtained for ni = 1. Therefore, in practical situations there is no reason to use a grid pattern with fingers in two perpendicular directions. (Author)

A80-49758 General formula for the incidence factor of a solar heliostat receiver system. L. Y. Wei (Waterloo, University, Waterloo, Ontario, Canada). *Applied Optics*, vol. 19, Sept. 15, 1980, p. 3196-3199. 7 refs.

A general formula is derived for the effective incidence factor of an array of heliostat mirrors for solar power collection. The formula can be greatly simplified for arrays of high symmetry and offers quick computation of the performance of the array. It shows clearly how the mirror distribution and locations affect the overall performance and thus provide a useful guidance for the design of a solar heliostat receiver system. (Author)

A80-50510 Electrowinning of silicon from K2SiF6-molten fluoride systems. G. M. Rao, D. Elwell, and R. S. Feigelson (Stanford University, Stanford, Calif.). (Electrochemical Society, Meeting, Los Angeles, Calif., Oct. 14-19, 1979.) Electrochemical Society, Journal, vol. 127, Sept. 1980, p. 1940-1944. 17 refs. Contract No. EY-76-503-0326.

The electrowinning of silicon from solutions of K2SiF6 in fluoride melts at 745 C has been achieved. Electrolysis close to the deposition potential gave dense, coherent, and well-adherent deposits. Up to 3 mm thick films were grown using a K2SiF6 concentration of 4-6 m/o. The polycrystalline silicon has a columnar structure with grain size up to 100 microns. The morphology of the electrodeposited silicon onto silver substrates and its dependence on the deposition parameters is discussed. The purity of the deposits is substantially higher than that previously reported for electrodeposited silicon. (Author)

A80-50625 Amorphous silicon solar cells. D. Adler (MIT, Cambridge, Mass.). Sunworld, vol. 4, no. 1, 1980, p. 16-19. 11 refs.

The development of amorphous silicon solar cells from crystalline silicon is presented, emphasizing the poor absorption of crystalline silicon with its indirect edge and the cost reduction from mass-production techniques. The two routes towards achieving cost-effective solar cells are discussed; by either reducing the total cost of crystalline-silicon solar cells or by increasing the efficiency of low-cost cells based on amorphous or polymeric conductors. The advantages of employing either routes are presented and it is noted that the deposition process of amorphous conductors is the most cost-effective, costing \$20/sq m compared to \$500/sq m for crystalline-silicon cells. Attention is given to the characteristics of amorphous and doped amorphous semiconductors and it is noted that the most efficient amorphous solar cells are constructed according to the Schottky-barrier configuration. Conclusions indicate that the development of solar cells decomposed from silane gas appears to be overcome by employing mixtures of silicon fluoride and hydrogen gas.

A80-50626 Concentrators and solar photovoltaics. M. C. Merchant (MCM Enterprises, Palo Alto, Calif.). *Sunworld*, vol. 4, no. 1, 1980, p. 21-25.

Methods for improving solar photovoltaic cells are presented, consisting of three functional areas: cell types, concentration methods, and tracking schemes. The need for developing new structures to efficiently cut circular wafers without increasing present cost is mentioned. Four constraints of the typical one-sun cell and its encapsulation are discussed, including the development of large-area cells, four-inch diameter wafers with uniform electrical characteristics, and the maximization of the amount of top surface illuminated by sunlight. Attention is given to concentrator solar cells that employ two fundamental methods of concentrating sunlight: by either reflecting or refracting light from a large area onto a small area with the aid of spot and linear focus. Several design concepts such as the Total Energy System, headlight, and conical design systems are presented together with various tracking schemes, including the dual-axis tracking system.

C.F.W.

A80-50627 Solaser power. M. M. Michaelis and P. T. Rumsby (Science Research Council, Rutherford and Appleton

Laboratories, Didcot, Berks., England). Sunworld, vol. 4, no. 1, 1980, p. 28, 29, 6 refs.

The paper discusses a method of obtaining a 24-hour, all season source of energy: the conversion of solar energy into laser power through an orbiting station. Several diagrams that show the function and process of solaser scheme, including the beaming of laser light after solar radiation is reflected by mirrors in space into a laser, are presented. Attention is given to the computer coding that models the way high-power lasers 'burn holes' in dense plasmas as well as to the effects of solaser interaction with the atmosphere. Several advantages of employing solaser power are discussed such as solasers for burning oil slicks, and cleaning snow from mountain-pass roads and fog from runways.

C.F.W.

A80-50633 Satellite power systems for Western Europe-Problems and solution proposals (Energiesatelliten für Westeuropa-Probleme und Lösungsansätze). J. Ruth and W. Westphal (Berlin, Technische Universität, Berlin, West Germany). Zeitschrift für Flugwissenschaften und Weltraumforschung, vol. 4, July-Aug. 1980, p. 224-230: 12 refs. In German.

This paper deals with the potential utilization of solar satellite power systems (SPS) as baseload powerplants for Western European countries. There are significant differences compared with the U.S.A. for geographical, political, organizational, orbital, and industrial reasons. These differences have been analyzed and critically examined, but no unsurmountable problems have been found. There exist, however, a lot of challenging problems to be solved prior to a full scale SPS development. In this paper some of the most important problems are presented and some potential solutions are discussed. Finally, a research program is proposed, which could help to answer the following question: Is it possible to develop, construct and operate an SPS system which is (1) economically viable, (2) technically feasible, (3) environmentally compatible, and (4) politically acceptable. (Author)

A80-50745 Theoretical analysis of new wavelength-division solar cells. S. Sakai and M. Umeno (Nagoya Institute of Technology, Nagoya, Japan). *Journal of Applied Physics*, vol. 51, Sept. 1980, p. 5018-5024. 19 refs.

The new wavelength-division solar cell is proposed and its conversion efficiency is calculated. The proposed diode structure can be fabricated by the usual epitaxial growth technique. The considered materials are the combination of InP In (0.58)Ga (0.42) As (0.84) P (0.16) having the band-gap energy of 0.827 eV. The calculated maximum conversion-efficiency is 19.5% at air-mass-zero condition which can be improved by the growth of a CdS window layer on the InP surface. With thick CdS on InP, 22.2% efficiency is obtainable, and when the thickness of CdS is as thin as 0.2 micron, 27% efficiency will be attainable. Fabrication of the proposed structure with the GaAlAs/GaAs system gives a conversion efficiency of 23.5% which is about the same as conventional heteroface or graded-band-gap solar cells. The optimum layer thicknesses that give maximum efficiency are also determined in this paper. (Author)

A80-50752 Short circuit current in indium tin oxide/silicon solar cells. R. Singh (Colorado State University, Fort Collins, Colo.). Journal of Applied Physics, vol. 51, Sept. 1980, p. 5064, 5065. 16 refs.

The short-circuit current density of indium tin oxide/single and polycrystalline silicon solar cells reported by Schunck and Coche (1979) is much higher than other silicon solar cells. It is shown that the short-circuit current density reported in the above reference does not represent the true value of these devices. (Author)

A80-50758 Open-circuit voltage of induced-junction solar cells. M. K. Alam and Y. T. Yeow (Queensland, University, Brisbane, Australia). Applied Physics Letters, vol. 37, Sept. 1, 1980, p. 469, 470. 8 refs. Research supported by the Department of National Development of Australia.

A numerical method is used to evaluate the open-circuit voltage of induced-junction solar cells as a function of substrate doping level and oxide charge. For a given oxide charge there is an optimum doping level at which V(OC) reaches a maximum. The equilibrium surface potential and the V(OC) increase with increasing oxide charge. The rate of increase, however, falls off sharply once the semiconductor surface is inverted. (Author)

A80-50800 Materials-related design issues in the solar central receiver pilot plant. J. C. Swearengen and S. L. Robinson (Sandia Laboratories, Livermore, Calif.). *Journal of Materials for Energy Systems*, vol. 1, Dec. 1979, p. 60-70. 29 refs. Contract No. DE-AC04-76DP-00789.

Materials-related issues in the design of the 10-MWe pilot plant of the Solar Thermal Central Receiver program of the Department of Energy, which is nearing the start of construction in Barstow, California, are discussed. Requirements for structural rigidity, reflectivity and glass integrity of the heliostat collector system are examined, and solutions adopted are indicated. Consideration is then given to the exposed receiver subsystem, with particular attention on the means and materials employed to assure a long service life. The sensible heat storage and electrical power generation subsystems are then discussed, and it is pointed out that no materials problems have arisen which may delay the pilot plant; issues are rather in the areas of ensuring low cost and longevity.

A.L.W.

A80-50816 Solar and wind energy - Its contribution to meeting future power requirements (Sonnenenergie und Windenergie - Ihr Beitrag an der zukünftigen Energiebedarfsdeckung). J. E. Feustel (M.A.N. Neue Technologie, Munich, West Germany) and B. Stoy (Rheinisch-Westfällisches Elektrizitätswerk AG, Essen, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 360-366. 9 refs. In German.

Modern concepts of solar energy conversion are reviewed with particular reference to the concept of a solar tower. The importance of solar energy as a factor in meeting future power requirements is noted. Recent progress in the design and development of large wind turbines is discussed.

V.P.

A80-50941 Energy conservation and solar houses. E. Shaviv. International Journal of Ambient Energy, vol. 1, Jan. 1980, p. 5-14: 5 refs.

The delicate interplay between energy conservation with direct solar gain (passive energy) and active solar systems for space heating in solar houses is discussed. The following design parameters are analyzed, taking into consideration energy conservation and solar gain: (1) the optimal slope of the collector roof; (2) southern windows or an active solar collector on south walls; (3) the trade-off between heavier insulation and a larger solar collector; and (4) the optimal mass of the internal partitions. The discussion is accompanied by results obtained from a case study.

(Author)

A80-50951 \* The solar power satellite concept - The past decade and the next decade. C. C. Kraft, Jr. and R. O. Piland (NASA, Johnson Space Center, Houston, Tex.). Space Solar Power Review, vol. 1, no. 1-2, 1980, p. 39-65. 20 refs.

The concept of using space sutellites to collect solar energy for earth use was first proposed in 1968. The present paper summarizes the results of various studies conducted since that time. The concept is now being evaluated by DOE and NASA. This evaluation will result in a recommendation as to whether the concept should be pursued further. A possible plan for the continued exploration of the concept is presented. The initial thrust of this plan would involve laboratory development and testing of selected system elements to answer key technological and environmental questions. (Author)

A80-50952 Status of the satellite power system concept development and evaluation program. F. A. Koomanoff (U.S. Department of Energy, Satellite Power System Projects Office, Washington, D.C.) and C. A. Sandahl (Argonne National Laboratory,

Washington, D.C.). Space Solar Power Review, vol. 1, no. 1-2, 1980, p. 67-77. 22 refs.

This article presents the status of the joint Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA) Satellite Power System (SPS) Concept Development and Evaluation Project (CDEP) as of October 1979. The evaluation procedure is described including the definition of the Reference System for which the assessments (environmental, societal, and comparative) are being made. The provisions for public involvement and information organization and dissemination are described. Some preliminary findings are presented. (Author)

A80-50953 Rockwell Satellite Power System /SPS/ concept definition studies. G. M. Hanley (Rockwell International Corp., Pittsburgh, Pa.). Space Solar Power Review, vol. 1, no. 1-2, 1980, p. 79.95

Evolution of SPS concepts since initiation of the DOE/NASA system studies is described. Early studies included solar thermal, solar photovoltaic, and nuclear concepts, all of which had microwave transmission systems. As a result of these earlier studies, three concepts were considered to be viable SPS candidates: (1) a Rankine solar thermal concept, (2) a silicon solar array photovoltaic concept, and (3) a gallium arsenide (GaAs) solar array photovoltaic concept. The Rockwell effort has since been concentrated on the GaAs photovoltaic concept. The major characteristics of this system are described. Alternatives to this system considered during the past year also are described. A summary is presented of ground and space construction, the space transportation system elements, and the SPS program.

A80-50955: Feasibility of siting SPS rectennas over the sea. P. Q. Collins (Imperial College of Science and Technology, London, England). Space Solar Power Review, vol. 1, no. 1-2, 1980, p. 133-144, 26 refs.

The feasibility of constructing sea-based rectennas for the reception of satellite power station energy intended to supply western Europe is examined. Three different approaches to the design of such structures are considered, including a rigid piled support structure, an artificial island, and a flexible, floating structure, and the costs of these approaches are estimated. It is shown that cost minimization in a system employing a marine rectenna would require a larger satellite transmitting antenna and a different illumination function across the microwave beam, which would result in energy costs only 10-15% higher than the baselinand-based design. Recommendations are presented concerning further work on the siting of marine rectennas.

A.L.W.

A80-50956 The photoklystron. J. W. Freeman, S. Simons, W. B. Colson, F. R. Brotzen, and J. Hester (Rice University, Houston, Tex.). Space Solar Power Review, vol. 1, no. 1-2, 1980, p. 145-154. 5 refs. Research supported by the Brown Foundation of Houston.

This paper discusses a new device which oscillates at radio frequencies when illuminated by light. It was originally conceived as a reflex klystron with the thermionic electron source replaced by a photoemitter. In practice, the photoklystron has been found to have different properties from what might be expected by simply scaling a reflex klystron to lower electron energies and oscillation frequencies. These include electron energy exchange with the RF field on multiple oscillations and plasma effects. The device can be made to 'self-oscillate;' that is, no external accelerating bias voltage is necessary. The energy to sustain oscillation is derived solely from the photoelectrons. An electrical efficiency of 1% has been demonstrated for the first test model photoklystron. An ultimate efficiency of 10% appears possible. A solar power satellite configured with photoklystrons might be weight and cost competitive with solar cell designs.

A80-50962 # Transient thermal behaviour of solar ponds. S. Sivasegaram and N. E. Wijeysundera (University of Sri Lanka,

Peradeniya, Sri Lanka). Regional Journal of Energy, Heat and Mass Transfer, vol. 1, Dec. 1978, p. 7-13. 7 refs.

The solar pond is a pool of salt water with a salt concentration gradient in the vertical direction. It is free from thermal convection effects and therefore, can serve as an economic solar collector device. All investigations to this date appear to have paid no attention to the transient behavior of the solar pond. The present work deals with the development of calculation procedures for the prediction of the transient thermal behavior of the pond. The report presents some interesting conclusions about the transient thermal behavior of the pond. (Author)

A80-50968 A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs. B. W. Jones (Open University, Milton Keynes, Bucks., England). Applied Energy, vol. 6, Sept. 1980, p. 329-346. 5 refs.

An integrated collector and inter-seasonal store (Prometheus), capable of supplying 100 per cent of low-grade heat needs even at mid-latitudes, is described. The design parameters are investigated theoretically, using sinusoidal insolation and load and real data. Costs are also estimated. A prima facie case is established for the technical, social and economic feasibility of the Prometheus type of device.

(Author)

A80-50971 Pressure loss in a spiral solar energy collector.
P. K. C. Pillai and R. C. Agarwal (Indian Institute of Technology, New Delhi, India). Applied Energy, vol. 6, Sept. 1980, p. 363-369. 7 refs

A knowledge of the magnitude of pressure loss in a spiral solar collector for different flow rates is important not only because of its influence upon the power required to circulate a given fluid, but also because of its effect upon the efficiency of the collector. Experiments have been performed to determine the pressure losses in spiral solar collectors of different lengths for different flow rates. Three spirals - A, B and C - of different lengths but identical in nature were prepared from a polythene tube. Corroboration of theoretical predictions occurs for Re less than or equal to 3000. For higher values of Reynold's number (up to 10,000), excellent agreement between theory and experiment ensues. (Author)

A80-51112 Degradation of solar cell performance by areal inhomogeneity. F. A. Lindholm, J. A. Mazer (Florida, University, Gainesville, Fla.), J. R. Davis (Westinghouse Research and Development Center, Pittsburgh, Pa.), and J. I. Arreola (Instituto Nacional de Astrofísica, Optica y Electrónica, Puebla, Mexico). Solid-State Electronics, vol. 23, Sept. 1980, p. 967-971. 18 refs. Research sponsored by the Solar Energy Research Institute.

Calculations have been made that show how severely areal inhomogeneity can degrade solar-cell conversion efficiency. Two general types of areal inhomogeneity are discussed. In the first type, the emitter recombination current controls the I-V characteristics for voltages near the maximum power voltage, and areal variations in the structural or material parameters of the emitter are assumed to occur. For this type of areal inhomogeneity, the base recombination current controls the dark I-V characteristics, and areal variations in the base minority-carrier lifetime are assumed to occur. For this type, the poor-quality area again dominates in determining the conversion efficiency, though less strongly than for the first type of areal inhomogeneity. An extension of the method used to demonstrate this behavior can provide a first order solution of the general three-dimensional boundary:value problem resulting from areal inhomogeneity; this extension is briefly described. (Author)

A80-51115 Temperature effects in silicon solar cells. A. Agarwala, V. K. Tewary (Birla Institute of Technology and Science, Pilani, India), S. K. Agarwal, and S. C. Jain (Solid-State Physics Laboratory, Delhi, India). Solid-State Electronics, vol. 23, Oct. 1980, p. 1021-1028. 33 refs.

The relative spectral response and the change in short circuit

current and open circuit voltage of solar cells have been measured. The temperature variations of the absorption coefficient of light, lifetime and diffusion coefficient of minority carriers are discussed. The effect of these parameters, as well as of junction depth and surface recombination velocity, on the performance of cells at different temperatures is analyzed.

V.T.

A80-51118 Distributed series resistance in photovoltaic devices - Intensity and loading effects. G. M. Smirnov (Solar Power Corp., Woburn, Mass.) and J. E. Mahan (Colorado State University, Fort Collins, Colo.). Solid-State Electronics, vol. 23, Oct. 1980, p. 1055-1058.

The paper presents detailed quantitative results from the computer simulation of the behavior of a photovoltaic device having a large distributed series resistance component (due to the sheet resistance of the emitter layer). An appropriate equivalent lumped series resistance for the model device is defined and found to vary significantly with the terminal condition and with the incident intensity. Device behavior is modeled for light-generated current densities corresponding to the illumination range about 1/10 to about 3 x AM1 over a conventional silicon solar cell. It is apparent from the computer simulation that series resistance output losses for such a device cannot be characterized by a constant equivalent lumped series resistance over the normally expected range of operating conditions. (Author)

A80-51208 End-use matching of solar energy systems. F. Kreith, D. Kearney (Solar Energy Research Institute, Golden, Colo.), and A. Bejan (Colorado, University, Boulder, Colo.). (U.S. Department of Energy, Workshop on the Second Law Analysis of Energy Devices and Processes, Washington, D.C. Aug. 14-16, 1979.) Energy (UK), vol. 5, Aug. Sept. 1980, p. 875-889; Discussion, p. 889, 890. 5 refs. Research supported by the U.S. Department of Energy.

End-use matching, a procedure for introducing solar energy into the national energy infrastructure, results in an identification of the most cost-effective combination of process energy needs, solar collector technology, geographic location, and economics by matching currently available solar system hardware with particular industrial processes and their locations. End-use matching is a planning tool for determining where and why general applications solar systems appear economically viable in the near future. End-use matching methodology is discussed, and first and second law thermodynamics analyses applied to a solar system producing process steam are illustrated. (Author)

A80-51463 Dimensionless groupings for photovoltaic performance analysis. A. Brandstetter (Weizmann Institute of Science, Rehovot, Israel) and J. Bani (Tel Aviv University, Tel Aviv, Israel).

Energy Conversion and Management, vol. 20, no. 2, 1980, p. 119-125, 11 refs.

Quantities of interest in photovoltaic performance analysis, in particular those related to the maximum power point such as the so-called fill-factor, are calculated in closed form under inclusion of series and shunt resistances. The successful derivation of such explicit forms involves the introduction of a 'characteristic device resistance' defined in terms of open-circuit voltage and short-circuit current, and of certain dimensionless groupings describing the equivalent-circuit variables and its parameters. Very simple and transparent relations are shown to exist between the dimensionless groupings, and examples of transformations between these relations and conventional I-V relations are presented. Close agreement against published data is shown to result.

A80-51677 Synthesis of four bar linkages for solar tracking. A. D. Dimarogonas and A. Mourikis (Patras, University, Patras, Greece). Solar Energy, vol. 25, no. 3, 1980, p. 195-199. 5 refs.

A method is presented for the synthesis of four bar linkages to provide adequate tracking of solar collectors. The design procedure starts with the selection of a number of accuracy points on the altitude vs hour function to yield a first form of a four bar linkage. An optimization algorithm improves on the original design for minimum error and optimum structural characteristics. Based on the method, mechanisms were designed for a certain locality with negligible tracking error, acceptable even for focusing collectors. This design procedure can yield inexpensive, yet accurate enough tracking with very simple seasonal adjustment.

(Author)

A80-51678 New reflector design which avoids losses through gaps between tubular absorbers and reflectors. W. R. McIntire (Argonne National Laboratory, Argonne, III.). Solar Energy, vol. 25, no. 3, 1980, p. 215-220. 8 refs. Contract No. W-31-109-eng-38.

The present paper deals with a reflector design that eliminates the loss of solar radiation through the gap between a tubular absorber and a reflector. With this design, higher optical efficiency can be obtained by eliminating the gap losses and enhancing the net absorptance of the receiver tubes. Effective operation has been achieved for gaps as wide as one-half the absorber-tube radius. V.P.

A80-51679 Maximum solar flux concentration achievable with axicon collectors. U. H. Kurzweg (Florida, University, Gainesville, Fla.). Solar Energy, vol. 25, no. 3, 1980, p. 221-223.

The concentration characteristics of coaxial cone axicon concentrators using the sun as the radiation source are examined. By employing a ray tracing approach and the known concentration result for rays entering strictly parallel to the axicon axis, it is shown that the concentration remains finite and that the maximum achievable value is 273 at the optimum reflector cone angle of 90 deg. All radiation entering the solar tracking collector will strike the central absorber cone as long as the vertex angle of this cone exceeds the angular size of the sun. (Author)

A80-51680 Solar energy utilization by carbanion photolysis. M. A. Fox and N. J. Singletary (Texas, University, Austin, Tex.). Solar Energy, vol. 25, no. 3, 1980, p. 225-229. 25 refs. Research supported by the Robert A. Welch Foundation and U.S. Department of Energy.

Photolysis of a variety of hydrocarbon anions with visible or long wavelength. UV light leads to several classes of photoreactions. Orbital topology-controlled anionic photorearrangements and the occurrence of photoinduced electron transfers may be general pathways for anionic excited states. These reactions find application in the utilization of solar energy either in photochemical energy storage reactions or in photoelectrochemical cells. (Author)

A80-51681 Optimum working fluids for solar powered Rankine cycle cooling of buildings. E. Wali. *Solar Energy*, vol. 25, no. 3, 1980, p. 235-241. 48 refs.

A number of fluids were screened for their operational reliability and thermal stability as working fluids for domestic solar Rankine cycle cooling. The results indicate that the halogenated compound R-113, followed by the fluorinated compound FC-88, is best suited for safe Rankine cycle operation. Further dynamic investigations are, however, needed to study the thermal stability of these fluids in the presence and absence of lubricants in copper, steel, and alloy conduits.

V.P.

A80-51682 Ammonia/water absorption cycles with relatively high generator temperatures. A. M. Johnston (Sydney, University, Sydney, Australia): Solar Energy, vol. 25, no. 3, 1980, p. 243-254. 12 refs.

It is shown that the performance of single-state ammonia/water absorption cycles (COPs up to 0.8) is appreciably superior to that of commercial single-state water/lithium bromide appliances (COPs up to 0.72), with ammonia/water cycles having the additional advantage of satisfactory operation with air cooling and in refrigeration and heat pump modes, if high-temperature collectors, such as evacuated tubular collectors, are available. In particular, the improved performance of the two-stage cycle should permit improvement in overall steady-state system performance when used in conjunction with evacuated tubular collectors.

V.P.

A80-51684 Solar radiation incident on tilted flat surfaces in Barcelona, Spain. M. Villarrubia, A. Coronas, and M. Llorens (Barcelona, Universidad, Barcelona, Spain). Solar Energy, vol. 25, no. 3, 1980, p. 259-263.

A80-51685 Estimating solar irradiation sums from sunshine and cloudiness observations. A. J. Biga and R. Rosa (Laboratório Nacional de Engenharia e Tecnologia Industrial, Sacavem, Portugal). Solar Energy, vol. 25, no. 3, 1980, p. 265-272. 5 refs. Junta Nacional de Investigação Científica e Tecnológica Contract No. 131,79,108.

A80-51686 Simulation of a solar energy system by means of an electrical resistance network. H. F. W. de Vries and J. C. Francken (Groningen, Rijksuniversiteit, Groningen, Netherlands). Solar Energy, vol. 25, no. 3, 1980, p. 279-281.

A80-51687 Predicted effect of grid line aspect ratio on the performance of solar cells. A. Flat (Hewlett Packard Co., Optoelectronics Div., Palo Alto, Calif.) and A. G. Milnes (Carnegie-Mellon University, Pittsburgh, Pa.). Solar Energy, vol. 25, no. 3, 1980, p. 283, 284.

In the present paper, the importance of reducing the aspect ratio of the grid lines in concentrator cells to minimize power losses is demonstrated quantitatively. The analysis predicts a significant performance improvement from the use of multilayer grid structures.

A80-51950 \* An overview of NASA's participation in the nation's energy program. R. D. Scott (NASA, Office of Aeronautics and Space Technology, Energy Systems Div., Washington, D.C.). (n: A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980.

Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 6-1 to 6-21. 8 refs.

The activities of the NASA Office of Solar Terrestrial System are reviewed. Consideration is given to solar heating and cooling, wind energy systems, solar cells, and the solar thermal power program.

B.J.

A80-51951 Solar opportunities - Domestic and international. R. San Martin (U.S. Department of Energy, Washington, D.C.). In: A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980.

Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 6-23 to 6-36.

The Department of Energy management approach for the solar and conservation activities is described, emphasizing the role of the Solar Energy Research Institute, Regional Solar Energy Centers, and Solar International Programs. It is shown how these diverse activities are brought together using a management approach which is similar to the NASA model.

A80-52075 Alternative configurations for sodium-cooled solar thermal power plants. B. D. Pomeroy and R. M. Salemme (GE Research and Development Center, Schenectady, N.Y.). (Institute of Electrical and Electronics Engineers, Winter Meeting, New York, N.Y., Feb. 3-8, 1980.) IEEE Transactions on Power Apparatus and Systems, vol. PAS-99, Sept.-Oct. 1980, p. 2012-2019. Contract No. EM-78-C-03-1725.

A parametric analysis performed to determine the most promising sodium-cooled plant configuration is described. The selected concept has enclosed plastic heliostats arranged around a cylindrical external receiver. Sodium flow in the receiver is controlled by electro-magnetic pumps to maintain a peak sodium temperature of 593 C. The storage system consists of separate hot and cold tanks with flow throttling to maintain low pressure. Electricity is generated with a reheat steam turbine having steam conditions of 16.6 MPa/538 C/538 C. (Author)

A80-52280 \* SOLARES orbiting mirror system. K. Billman (NASA, Ames Research Center, Moffett Field, Calif.). In: Remember the future - The Apollo legacy; Proceedings of the Meeting, San Francisco, Calif., July 20, 21, 1979. San Diego, Calif., American Astronautical Society, 1980, p. 15-26. (AAS 79-304)

Hardware characteristics and applications opportunities of large orbital mirrors, as determined to date by NASA's 'SOLARES' program are assessed. Assuming Space Shuttle availability, methods and timetables for the deployment of these thin film-covered structures are presented, and comparisons are made between electricity-production values of terrestrial solar-energy systems to which SOLARES units deliver high-intensity insolation, on one hand, and on the other the various conventional generation systems. Electrolytic and photochemical production of gaseous and liquid fuels is also compared to synthetic hydrocarbon fuels derived from fossil sources, with considerable attention to project economics and overall process efficiencies.

O.C.

A80-52498 n-CdS/p-Si heterojunction solar cells. C. Coluzza, M. Garozzo, G. Maletta, D. Margadonna, R. Tomaciello (Assoreni, Laboratori Ricerche di Base, Monterotondo, Italy), and P. Migliorato (Roma, Università, Rome, Italy). Applied Physics Letters, vol. 37, Sept. 15, 1980, p. 569-572. 11 refs.

The photovoltaic properties of n-CdS/p-Si heterojunctions prepared by vacuum deposition of CdS:In on single-crystal silicon substrates are reported. Power conversion efficiencies of 9.5 percent (cell area 1.5 sq cm) have been obtained. The I-V characteristics and their temperature dependance suggest tunneling as the dominant conduction mechanism. (Author)

A80-52826

National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Conference sponsored by the U.S. Department of Energy and International Solar Energy Society; Contract No. DE-AC01-79CS-30032. Edited by H. Miller, M. Riordan, and D. Richards. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979. 958 p. Members, \$19.; nonmembers, \$65.

The Conference focused on passive solar energy, Trombe wall and direct gain designs, windows and daylighting, computer-aided design, natural convection economic analysis, cooling in dry and humid climates, domestic scale greenhouses, and building applications. Papers were presented on solar modulators, economic feasibility of passive solar space heating systems, air-cooling solar collectors, classification of passive and hybrid heating and cooling systems, and spectral measurements of infrared sky radiance.

A.T.

A80-52827 A thermal performance evaluation technique for passive space heating systems. M. W. Weston (IBM Corp., Huntsville, Ala.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 31-34, 32 refs.

The paper describes a method of thermal performance evaluation of buildings which use passive solar space heating. The method applies a difference technique based on energy balance; the solar energy input is determined by the difference between the building load and thermal energy from other sources. Errors in infiltration models were reduced using system measurement data from the National Solar Heating and Cooling Demonstration Program; the uncertainties in the computation of the space heating load were minimized by an iterative method called energy balance calibration.

A80-52828 Trombe wall vs direct gain · A comparative analysis of passive solar heating systems. W. O. Wray and J. D. Balcomb (California, University, Los Alamos, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 41-47. 7

refs. Research sponsored by the U.S. Department of Energy.

Analysis calculations for the Trombe wall and direct gain buildings in Albuquerque, N. Mex. and Madison, Wis. are presented. Trombe walls achieve higher solar fractions on a limited amount of solar mass, outperforming direct gain buildings for thermal storage masses up to 175 lb/sq ft of glazing walls. For thermal storage masses exceeding this value, direct gain buildings are better than the Trombe wall construction. The Trombe wall is superior to direct gain with respect to thermal comfort; both types of structures undergo equivalent uniform temperature swings which exceed the thermostatically imposed air temperature boundaries at the upper and lower limits.

A.T.

A80-52829 The effect of design parameter changes on the performance of thermal storage wall passive systems. R. D. McFarland and J. D. Balcomb (California, University, Los Alamos, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 54-60. Research supported by the U.S. Department of Energy.

Hour-by-hour computer simulations based on one year of solar radiation and temperature data are used to analyze annual energy savings in thermal storage wall passive designs both Trombe wall and water wall cases. The calculations are rerun many times changing various parameters one at a time to assess the effect on performance. Parameters analyzed are: night insulation R-value, number of glazings, wall absorptance and emittance, thermal storage capacity, Trombe wall properties and vent area size, additional building mass, and temperature control set points. Calculations are done for eight cities. (Author)

A80-52830 Determining the optimum design of the solar modulator. R. M. Lebens (Arcaed, London, England). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 100-106.

The paper discusses reflective louvers used in solar buildings, their design limitations, and testing for optimum spacing and radius of curvature. Constraints imposed on louver design include a requirement that sunlight reflected by the solar modulator does not produce a blinding glare; the horizontal alignment of the slats is critical and should not be allowed to change with the age of the louver. Modeling of the sun movement is discussed, describing a sun angle calculator and simulation tests to determine slat spacing and optimum radius of curvature for different latitudes.

A.T.

A80-52831: Applications of DOE-1 to passive solar heating of commercial buildings - Preliminary results. B. D. Hunn, N. M. Schnurr, J. L. Peterson, J. F. Kerrisk, and J. E. Moore (California, University, Los Alamos, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 159-163. 7 refs.

Research sponsored by the U.S. Department of Energy.

The DOE-1 building energy analysis computer program is being modified to include analysis of passive solar and large thermal mass heating and cooling systems. Sunspot is a detailed thermal network computer program developed for direct-gain systems as a reference analysis tool to compare with DOE-1. It was validated by comparison of calculated results with experimental test cell data. A series of runs was then made to determine the sensitivity of solar fraction to type of glazing, location and quantity of mass, and method of computing infrared radiant interchange among inside surfaces. Simulations using DOE-1 in its present form indicate that the weighting factors used in the program are not satisfactory for large-mass direct-gain systems; however, it does appear that the weighting factor approach can be retained if an efficient method of determining weighting factors appropriate to passive systems can be developed. Future work will proceed in that direction. (Author)

A80-52832 The economic feasibility of passive solar space heating systems. J. W. Taul, Jr., C. Y. Moncrief, and M. L. Bohannon (Mitre Corp., McLean, Va.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 186-191. 9 refs.

The paper examines economic acceptability of passive space heating including electric resistance methods and heat pump systems in family dwellings. Feasibility of heating systems was determined by life-cycle and initial costs, time to simple payback, and tax credits required to reduce payback time. Performance/cost predictions were based on performance algorithms, building costs which reflect increased insulation and 'tightness' of construction in cold climates, and projected fuel prices.

A.T.

A80-52833 Experimental investigation of the Trombe wall passive solar energy system. R. L. Casperson and C. J. Hocevar (Energy Engineering Group, Inc., Golden, Colo.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 231-235. Research supported by the U.S. Department of Energy.

The paper describes a test facility for determining the performance of a Trombe wall heating system. The facility was designed to determine heat transfer properties of the collector system and to evaluate the thermal performance of the test building. Test equipment provided a means of varying the gap between the masonry wall and the glazing panel, and changing the inlet and outlet duct geometries. The wall was instrumented with thermocouples which measure temperature distribution; the thermocouples were also imbedded in the envelope of the building to estimate overall building energy balances. Measurements of velocity and temperature profiles were made in the gap between the glazing and the wall to investigate air flow velocity and asymmetric effects.

A.T.

A80-52834 Measurement of natural convection in aircooled solar collectors. W. L. Borst and J. L. Higginbotham (Southern Illinois University, Carbondale, III.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 236-240. 8 refs.

The natural convection in an air-cooled solar collector has been studied in detail. Quantitative results were obtained for the mass flow rate, air temperature rise, collector efficiency, and the effective heat transfer and loss coefficients as a function of collector absorber power. The absorption of solar radiation in the collector was simulated with a heater plate in place of the usual absorber. This made it possible to obtain reproducible results in the laboratory and facilitate the measurements. The collector was purposely of simple design to allow a physical interpretation of the results. The air flow took place between the flat absorber plate and the inner collector cover. No fins or other heat output augmenting devices were used. The inlet and outlet of the collector had the same cross-sectional dimensions as the air gap in the collector. The observed dependence of the mass flow rate and air temperature rise on the absorber power could be interpreted by considering basic thermosiphon and turbulent flow principles. (Author)

A80-52835 A classification scheme for the common passive and hybrid heating and cooling systems. M. J. Holtz (Solar Energy Research Institute, Golden, Colo.), W. Place, and R. C. Kammerud (California, University, Berkeley, Calif.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc., New York, N.Y., Unipub, 1979, p. 282-289. Research supported by the U.S. Department of Energy.

A systematic nomenclature and classification scheme is proposed for passive space heating and cooling systems. It is based upon the mode of energy transport to and from the space and the environmental resource from which the energy is received or to

which it is discharged. A number of passive and hybrid space heating and cooling systems are characterized. (Author)

A80-52836 Predicting passive solar performance using modal expansions. C. Carter (Trent University, Peterborough, Ontario, Canada). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 309-313. 6 refs.

This paper discusses passive heat storage, using analytic solutions of the linear heat conduction equation, expressed as truncated infinite series of exponentially decaying modes. A 3 mode model gives an accurate description of detailed thermal performance, but single mode models, suitable for development as architectural design tools, give reasonable estimates of overall performance over a daily (or longer) cycle. Several single mode models are compared with the 3-mode model for a Trombe solar wall, and for a passive solar building with south facing windows and north wall storage. (Author)

A80-52837 A comparison of performance factors for passive solar heating. L. Palmiter and B. Hamilton (National Center for Appropriate Technology, Butte, Mont.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 318-322. 8 refs.

The paper reviews methods of calculating performance factors for buildings with passive solar heating. The amount of auxiliary heating was compared with the reference space heating load; various means for computing the reference load were analyzed as combinations of a choice of a reference loss coefficient and a choice of a reference temperature. The resulting differences in the computed performance were illustrated with an example of a direct gain type building.

A.T.

A80-52838 A semi-empirical method for estimating the performance of direct gain passive solar heated buildings. W. O. Wray, J. D. Balcomb, and R. D. McFarland (California, University, Los Alamos, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings.

Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 395-402. 6 refs. Research supported by the U.S. Department of Energy.

The Sunspot code for performance analysis of direct gain passive. solar heated buildings is used to calculate the annual solar fraction for two representative designs in 10 American cities. The two representative designs involve a single thermal storage mass configuration which is evaluated with and without night insulation. In both cases the solar aperture is double glazed. The results of the detailed thermal network calculations are then correlated using the monthly solar load ratio method which has already been successfully applied to the analysis of both active solar heated buildings and passive, thermal storage wall systems. The method is based on a correlation between the monthly solar heating fraction and the monthly solar load ratio (the ratio of the monthly solar energy transmitted through the glazing aperture to the building's monthly thermal load). The procedure using the monthly method for any location is discussed in detail. In addition, a table of annual performance results for 84 cities is presented, enabling the designer to bypass the monthly method for these locations.

A80-52839 Simple design calculation procedure for passive solar houses. M. Lumsdaine and E. Lumsdaine (New Mexico State University, Las Cruces, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 410-414. 8 refs. Research supported by the New Mexico Energy and Minerals

A simplified design calculation procedure has been developed as a useful tool for designers of passive solar houses to estimate

performance and size backup equipment. The procedure, with supporting climatic data, has been specifically developed for New Mexico; however, with different climatic data input, its applicability can be extended to other states and/or regions. Worksheets are given to calculate the modified building heat loss coefficient per gross floor area (C(B)/A); a table of satisfactory values of C(B)/A for well built passive solar houses is provided as a checkpoint. Worksheets are also used to determine the building net thermal load, the solar heat gain for each passive mechanism, and the auxiliary load profile via the solar load ratio and solar heating fraction. The method has been compared with computer calculations and some operating experience and has been found to compare favorably in overall accuracy and ease of use. Some of the solar 'effectiveness' factors may need to be refined through future comparison with more operating experience; the lack of published data in sufficient detail was found to be a hándicap. (Author)

A80-52841 Solar hot air balloons. W. S. Morris. In:
National Passive Solar Conference, 3rd, San Jose, Calif., January
11-13, 1979, Proceedings.
Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p.
518-524.

The paper describes a solar hot air balloon designed as a simple solar collector which warms the air to create positive buoyancy. Several proposed types including a black skin balloon, a scheme with a clear outer skin and an inner black bag, and a clear structure with interior collectors are depicted; their heat gains, conduction losses, solar insolation, and lift potentials are analyzed. Balloon weights and materials including thin black tissue paper and Mylar used for their skins are specified, and methods of inflating them by solar chimneys are discussed. The balloon was tested in 1978 in New Mexico and Oklahoma.

A.T.

A80-52842 Cost and thermal performance comparisons for wall systems as applied to passive solar building. R. D. Taylor (Communico, Inc., Santa Fe, N. Mex.). In: National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings. Newark, Del., International Solar Energy Society, Inc.; New York, N.Y., Unipub, 1979, p. 905-909.

A80-52860 Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979. 94 p. \$14.86.

Papers are presented on the technology and future prospects for photovoltaic solar energy conversion. Specific topics include the principles of solar cell operation, the prospects for cost reduction in future silicon photovoltaic cell manufacturing processes, thin-film cuprous sulphide-cadmium sulphide solar cells, amorphous silicon solar cells, gallium arsenide solar cells for use in solar collectors, a hydrophotovoltaic plant for peak power generation in central and northern Europe, hybrid thermal-photovoltaic systems, and the status and prospects of photovoltaic solar energy conversion. A.L.W.

A80-52861 Silicon solar cell array technology and the prospects for cost reduction. A. V. Whale (Ferranti Electronics, Ltd., Oldham, Lancs., England). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 13-23. 36 refs.

The current state and future development of terrestrial silicon photovoltaic array technology are reviewed. Consideration is given to the cell manufacturing technology of: (1) the present phase, which is derived from the technology employed in the conventional semiconductor device and integrated circuit industry based on wafers sawn from Czochralski ingots and is aimed at a market of remote low power consumption power supplies and moderate power level sponsored demonstration projects; (2) the second phase, which is expected to employ a similar technology with increased automation

however based on a less expensive starting material such as sawn polycrystalline or single crystal silicon or ribbons; and (3) the third phase, in which the cost is comparable to that of conventionally generated power so that the market is a significant proportion of the total energy demand and the processing is based on amorphous silicon. The development of module technology, which is not expected to exhibit dramatic cost reductions, is also examined.

A.L.W.

A80-52862 Thin film cuprous sulphide-cadmium sulphide solar cells. R. Hill (Newcastle-upon-Tyne, Polytechnic, Newcastle-upon-Tyne, England). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979.

London, International Solar Energy Society, 1979, p. 25-35. 15 refs.

The physics of CuS-CdS solar cells are studied to determine practical efficiencies and difficulties. Present cell characteristics are determined by states at the junction, and it is shown that electron affinity matching by using Zn(0.2)Cd(0.8)S instead of CdS can lead to significant improvements. The techniques commonly used for producing the CdS-Cu2S cells are briefly reviewed and the characteristics of the cells discussed. Future commercial viability is considered; sputtered cells with dry-formed junctions and all-glass encapsulation have the potential to meet the technical and economic criteria necessary for large area production of low cost cells.

(Author)

A80-52863 Amorphous silicon solar cells. J. I. B. Wilson (Heriot-Watt University, Edinburgh, Scotland). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 37-44. 10 refs. Research supported by the Science Research Council and English Electric Co.

The advantages of amorphous silicon solar cells over crystalline cells are discussed, and the properties of amorphous silicon and its solar cells are surveyed. It is shown that amorphous silicon represents an inexpensive cell material for large-area solar cells which is easily acquired and has a developed technology. The production of n- or p-type amorphous silicon by a glow discharge through silane containing small amounts of phosphine or diborane is considered, and it is noted that up to 20 at. % H may be incorporated in this manner. The photocurrent responses of MIS and Schottky barrier amorphous silicon cells are discussed, noting solar energy conversion efficiencies of 5-6% attained, and difficulties posed by the collection of photocurrent, the reduction of the density of gap states, and low fill factors are indicated.

A.L.W.

A80-52864 Gallium arsenide solar cells for use in concentrated sunlight. B. L. H. Wilson (Plessey Research, /Caswell/, Ltd., Allen Clark Research Center, Towcester, Northants., England). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 45-54. 31 refs.

The properties of GaAs are reviewed in the context of high concentration cells. The main types of GaAs cells are described - the window cell with a high energy-gap face embodying AlAs is now common but efficient homojunction cells have also been made. Best cell efficiencies approach 22% at 1 sun and 25% at 1000 suns; further small improvements can be obtained. Tandem cells should give over 30%. Vapor phase epitaxy can approach efficiencies given by liquid phase epitaxy and is more suitable for large scale production. Polycrystalline cells may give further cost reductions. System costs are dominated by the cost of concentrators, which favors the use of efficient cells. GaAs is preferable to silicon above 300-500 suns. Competition with flat panels and the role for concentrator systems depend on radical approaches to concentrator design using low cost materials. (Author)

A80-52865 Hybrid thermal-photovoltaic systems. R. Mertens (Leuven, Katholieke Universiteit, Louvain, Belgium). In: Photovoltaic solar energy conversion; Proceedings of the Conference,

London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 65-71. 5 refs.

The performance of a hybrid photovoltaic/thermal flat plate collector is analyzed in terms of electrical and thermal efficiency and degradation. It is shown that low concentration factor hybrid systems combined with silicon cells optimized for high temperature operation can be economical in sunny areas if a need for electricity and low temperature thermal energy coincides. Hybrid systems with a high concentration factor combined with GaAs cells could be the best choice for sunny areas without significant need for low temperature heat. Experimental data are presented which illustrate the operation of a hybrid system using moderately concentrated sunlight.

V.L.

A80-52866 \* Photovoltaics in the U.S.A. - A progress report. R. G. Forney (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979. London, International Solar Energy Society, 1979, p. 81-91. Research sponsored by the U.S. Department of Energy and NASA.

The Federal Photovoltaics Program is reviewed with reference to price goals, program organization, technical developments, and various applications. The immediate goals of the program are: (1) to develop the Federal market by encouraging Government agencies to incorporate photovoltaic systems, and (2) to provide marketing support to commercial solar cell and system manufacturers whose growth is crucial to the ultimate success of the photovoltaic program. The program will initially provide for procurement of the smaller femote types of systems and will be broadened to include residential and intermediate load systems.

A80-52867 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings. Conference sponsored by the Solar Energy Industries Association. Washington, D.C., Solar Energy Industries Association, 1979. 203 p.

Topics discussed include the construction of a 150 KWe solar power integration system, the design of a low-cost solar concentrator, wind commercialization, and the DOE Solar Thermal Program. Attention is also given to the DOE Photovoltaic Program, the DOE view of solar power commercialization and applications, the JPL Small Power Systems Program, remote solar power cost comparisons with diesel generators, and osmotic pressure solar generation. A.C.W.

A80-52869 # DOE solar thermal power systems program. G. W. Braun (U.S. Department of Energy, Washington, D.C.). In: Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings. Washington, D.C., Solar Energy Industries Association, 1979, p. 96-125.

Solar thermal concentrator systems which utilize mirror/lens heat collection and conversion technologies are judged to become a major factor in the national energy market and found to adapt well to industrial facilities and power plants. The DOE solar thermal power systems program is summarized, emphasizing the applications of central receivers and distributed receivers and the development of an advanced technology program. Topics include the operation of a 10 MW central receiver pilot plant, the engineering developments on parabolic trough, hemispherical bowl, and parabolic dish concentrators as related to distributed receiver technology, and future projects and plans in the DOE program which are discussed in view of commercialization strategies.

A.C.W.

A80-52870 # DOE view of solar power commercialization and applications. F. H. Morse (U.S. Department of Energy, Office of Solar Applications, Washington, D.C.). In: Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings. Washington, D.C., Solar Energy Industries Association, 1979, p. 136-161.

The organization of the DOE Office of Solar Applications is

presented in relation to its role in the commercialization and market development of solar products. A program which is commonly used by industry for the development of solar products and their markets, called the Product Development Process, outlines the stages through which a candidate product must pass. When a solar product or system is ready for field tests and marketing, the responsibility for its support transfers to the Office of Solar Applications where three divisions address the activities of market analysis, systems development, market testing, institutional programs, and education and communications. The Solar Applications' plans for the commercialization of six solar technologies which include active heating and cooling, passive and hybrid solar systems, agricultural and industrial process heat, and wood are briefly discussed, with emphasis given to photovoltaic systems and small wind machines.

A.C.W.

A80-53263 High concentration solar collector of the stepped spherical type - Optical design characteristics. B. Authier and L. Hill (CNRS, Laboratoire d'Astronomie Spatiale, Marseille, France). Applied Optics, vol. 19, Oct. 15, 1980, p. 3554-3561. 8 refs.

An analysis of the optical design characteristics of a new high concentration solar collector is presented. This type of collector consists of spherical segments that are sections of a spherical cap by planes perpendicular to its axis. These ring-shaped spherical segments are so arranged along their common axis that the planes of their circles of least confusion are superposed. The optical characteristics and simulation of this system are developed to provide information for the engineering design of this type of solar energy collector system. The calculations are checked by a laser scanning onto a breadboard mock-up. (Author)

A80-53475 Solar powered absorption air conditioning. J. M. Vardon (South Australian Institute of Technology, Adelaide, Australia). *International Journal of Ambient Energy*, vol. 1, Apr. 1980, p. 117-126. 10 refs.

Artificial means of providing or removing heat from the building are discussed along with the problem of the appropriate building design and construction for a suitable heat climate inside the building. The use of a lithium bromide-water absorption chiller, powered by a hot water store heated by an array of stationary flat collectors, is analyzed. An iterative method of predicting the cooling output from a LiBr-water absorption refrigeration plant having variable heat input is described and a model allowing investigation of the performance of a solar collector and thermal storage system is developed.

S.S.

A80-53570 Performance characteristics of a commercially available, point-focus, solar power system. M. Bohn (Solar Energy Research Institute, Golden, Colo.). (American Institute of Chemical Engineers, National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 5-8, 1979.) AIChE Symposium Series, vol. 75, no. 189, 1979, p. 282-290. 9 refs.

The performance of a commercially available solar electric power system is described in terms of instantaneous electrical power output for a given insolation and electrical energy production per day. Receiver thermal loss coefficient and concentrator optical efficiency are measured and system performance is characterized with steam cycle efficiency and electrical generator efficiency as parameters. System performance is limited by a low optical efficiency of 44%. For peak insolation, this collector delivers 9.2 kW(th.) to the steam engine, representing 35% of the solar input.

(Author)

A80-53571 Dynamic simulation and development of a control strategy for a distributed, concentrating solar collector field. F. F. Klein (Westinghouse Electric Corp., Pittsburgh, Pa.). (American Institute of Chemical Engineers, National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 5-8, 1979.) AICHE Symposium Series, vol. 75. no. 189. 1979. p. 291-296.

In order to evaluate a control scheme for a solar energy system,

it was necessary to develop a dynamic simulation of the collector field which would incorporate the important effects and yet have short computer running time and be easily modified. Based on a program which uses fourth-order Runga-Kutta integration with an automatic error limiting variable time step method, the simulation was developed in four separate sections: receiver, interconnecting piping, flow network, and controller. It is shown that relatively simple modeling techniques provide a convenient way to evaluate the control concept. The proposed control concept is found to have good thermal performance and control stability.

A80-53572 Fluid selection for a 100 MW/e/ line focus solar central power station. J. M. Neill and J. R. Schuster (General Atomic Co., San Diego, Calif.). (American Institute of Chemical Engineers, National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 5-8, 1979.) AIChE Symposium Series, vol. 75, no. 189, 1979, p. 297-303. 5 refs. Contract No. ET-78-C-03-2240.

System point designs have been prepared for three fluids, including Therminol 88, draw salt (a 50% molar mixture of potassium nitrate and sodium nitrate), and sodium. The following qualitative and quantitative factors have been considered: capital cost, operation cost, cost uncertainties, development requirements, design flexibility, design credibility and marketability, reliability, and availability. Draw salt has been selected for the heat transport fluid based principally on projected system cost and acceptability. The problem of draw salt freeze up, which is the most significant operational problem, can be solved by heat tracing, proper piping system design, and proper system drainage.

N80-28565# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

INTEGRATED SOLAR RECEIVER/BIOMASS GASIFIER RESEARCH

C. Benham, P. Bergeron, G. Bessler, and M. Bohn Nov. 1979 9 p refs Presented at the Users Assoc. Solar Fuels Workshop, Albuquerque, N. Mex. 28-29 Nov. 1979 (Contract EG-77-C-01-4042)

(SERI/TP-333-507; CONF-791143-6) Avail: NTIS

HC A02/MF A01

Processes for producing liquid fuels from olefin rich pyrolysis gases obtained from fast pyrolysis of biomass are being developed. In the Diebold process the biomass, carried by steam, is blown through an entrained bed gasifier. The olefins are then separated from the rest of the reaction products and polymerized thermally to gasoline; the other gases are used as fuel for the process. The Kuester process uses a fluidized bed gasifier and a catalytic Fischer-Tropsch reactor which converts the olefins, hydrogen, and carbon monoxide into n-propanol and paraffinic hydrocarbons. The advantages over the Diebold process are shorter residence time and elimination of the gas separation requirement. One disadvantage is the low octane rating of the fuel. As part of the solar thermal program at the Solar Energy Research Institute (SERI), an entrained bed reactor/receiver for fast pyrolysis of biomass is being developed for use with either the Diebold or Kuester process.

N80-28569# Midwest Research Inst., Golden, Colo.
CONVERSION SYSTEM OVERVIEW ASSESSMENT.
VOLUME 3: SOLAR THERMAL/COAL OR BIOMASS
DERIVED FUELS

R. J. Copeland Feb. 1980 33 p refs (Contract EG-77-C-01-4042)

(SERI/TR-35-078-Vol-3) Avail: NTIS HC A03/MF A01

The conversion of synthetic fuels with solar thermal heat is discussed. The method is a hybrid combination of solar energy with either coal or biomass. A preliminary assessment of this technology is made by calculating the cost of fuel produced as a function of the cost of coal and biomass. It is shown that within the projected ranges of coal, biomass, and solar thermal costs, there are conditions when solar synthetic fuels with solar thermal heat will become cost competitive.

N80-28860\*# Spectrolab, Inc., Sylmar, Calif.
COPLANAR BACK CONTACTS FOR THIN SILICON SOLAR

CELLS Final Report, Jul. 1978 - Dec. 1979

Jay W. Thornhill and W. E. Sipperly Mar. 1980 36 p refs (Contract NAS3-21251)

(NASA-CR-159811) Avail: NTIS HC A03/MF A01 CSCL

A process for fabricating 2 to 3 mil wraparound solar cells was formulated. Sample thin wraparound cells were fabricated using this process. The process used a reinforced perimeter construction to reduce the breakage that occurs during handling of the wafers. A retracting piston post was designed and fabricated to help minimize the breakage that occurs during the screen printing process. Two alternative methods of applying the aluminum back surface field were investigated. In addition to the standard screen printed back surface field, both spin-on and evaporated aluminum techniques were researched. Neither spin-on nor evaporated aluminum made any noticeable improvement over the screen printing technique. A fine screen mesh was chosen for the application of the aluminum paste back surface field. The optimum time and temperature for firing the aluminum turned out to be thirty seconds at 850 C. The development work on the dielectric included looking at three dielectrics for the wraparound application. Transene 1000, Thick Film Systems 1126RCB and an in house formulation 61-2-2A were all tested. Cells with pre-dielectric thickness of 3.0-0-3.5 mils using Transene 1000 as the wraparound dielectric and the procedure outlined above showed an average efficiency of 10.7 percent. Thinner cells were fabricated, but had an unacceptable yield and efficiency. R.E.S.

N80-28861\*# Honeywell, Inc., Minneapolis, Minn. Energy Resources Center.

INSTALLATION GUIDELINES FOR SOLAR HEATING SYSTEM, SINGLE-FAMILY RESIDENCE AT WILLIAM OBRIEN STATE PARK, STILLWATER, MINNESOTA

May 1980 187 p Sponsored in part by DOE (Contract NAS8-32093)

(NASA-CR-161480) Avail: NTIS HC A09/MF A01 CSCL

Installation procedures for the single family residential solar heating system at the William O'Brien State Park, Stillwater, Minnesota, are presented. The system is a solar-assisted, hydronic-to-warm-air system with solar-assisted domestic water heating. It is composed of the following major components: liquid cooled flat plate collectors; water storage tank; passive solar-fired domestic water preheater; electric hot water heater; heat pump with electric backup; solar hot water coil unit; tube-and-shell heat exchanger, three pumps, and associated pipes and valving in an energy transport module; control system; and air-cooled heat purge unit. Installer guidelines are provided for each subsystem and includes testing and filling the system. Information is also given on the operating procedures, controls, caution requirements and routine and schedule maintenance. R.E.S.

N80-28863\*# Hughes Aircraft Co., El Segundo, Calif. Technology Div.

CONCEPTUAL DESIGN STUDY OF CONCENTRATOR ENHANCED SOLAR ARRAYS FOR SPACE APPLICATIONS. 2kW Si AND GaAs SYSTEMS AT 1 AU Final Report

20 Mar. 1980 55 p

(Contracts NAS7-100; JPL-955.194)

(NASA-CR-163046; HAC-E3256; JPL-9950-377) Avail: NTIS HC A04/MF A01 CSCL 19A

The effect of concentration level on the specific power for a deployable, thin, gallium arsenide cell array in geosynchronous orbit for 10 years in conjunction with a two dimensional flat plate trough concentrator (V trough) and also with a multiple flat plate concentrator was investigated as well as the effects for a conventional silicon cell array on a rigid substrate. For application to a thin GaAs array at 1 AU for 10 years, the V trough produces a 19% benefit in specific power and a dramatic reduction in array area, while the multiple flat plate collector design is not only of no benefit, but is a considerable detriment. The benefit it achieves by reducing array area is duplicated by the 2D design. For the silicon array on a rigid substrate improvement in performance due to a concentrator with ordinary

mirror coating is quite small: 9% increase in specific power, and 13% reduction in array area. When the concentrator mirrors are coated with an improved cold mirror coating, somewhat more significant results are obtained: 31% specific power improvement; and 27% area reduction. In both cases, a 10 year exposure reduces BOL output by 23%.

N80-28864\*# Westinghouse Research and Development Center. Pittsburgh, Pa.

SILICON WEB PROCESS DEVELOPMENT Annual Report,

Apr. 1979 - 1980 C. S. Duncan, R. G. Seidensticker, J. P. McHugh, F. E. Hill, M. E. Skutch, J. M. Driggers, and R. H. Hopkins 30 Jun. 1980 171 p refs

(Contract JPL-954654)

(NASA-CR-163386; DOE/JPL-954654-80/11; JPL-9950-378)

Avail: NTIS HC A08/MF A01 CSCL 10A

A barrier crucible design which consistently maintains melt stability over long periods of time was successfully tested and used in long growth runs. The pellet feeder for melt replenishment was operated continuously for growth runs of up to 17 hours. The liquid level sensor comprising a laser/sensor system was operated, performed well, and meets the requirements for maintaining liquid level height during growth and melt replenishment. An automated feedback loop connecting the feed mechanism and the liquid level sensing system was designed and constructed and operated successfully for 3.5 hours demonstrating the feasibility of semi-automated dendritic web growth. The sensitivity of the cost of sheet, to variations in capital equipment cost and recycling dendrites was calculated and it was shown that these factors have relatively little impact on sheet cost. Dendrites from web which had gone all the way through the solar cell fabrication process, when melted and grown into web, produce crystals which show no degradation in cell efficiency. Material quality remains high and cells made from web grown at the start, during, and the end of a run from a replenished melt show comparable efficiencies. FDK

N80-28869# Naval Surface Weapons Center, White Oak, Md. THERMOELECTRIC MATERIALS FOR SOLAR ENERGY CONVERSION Final Report, Aug. - Dec. 1978

J. F. Goff and J. R. Lowney 1 Feb. 1979 22 p refs Presented at 14th Intersol. Energy Conversion Eng. Conf., Boston, 5 Aug. 1979

(AD-A084948; NSWC/TR-79-247) Avail: HC A02/MF A01 CSCL 10/2

The thermoelectric efficiency index of N-type beta-SiC has been calculated by use of the Goff-Lowney integral formulation. The scattering parameters were estimated by fitting the thermoelectric power and electrical conductivity data of Golikova, et al. The parasitic photon thermal conductivity was calculated theoretically by use of the theory of Devyatkova, et al, while the lattice thermal conductivity was treated parametrically. The results indicate that there exists an optimum carrier concentration of approximately 2 x ten to the 20th power/ccm and that the efficiency is still increasing at 2000K. GRA

#### N80-28875# Oak Ridge National Lab., Tenn. PLASMA-SPRAYED COATINGS FOR VERY HIGH TEMPER-ATURE SQLAR ABSORBERS

James M. Schrever, Richard A. Hays (White Sands Missile Range). Charles R. Schmitt (Oak Ridge Y-12 Plant), and Darrell Farwell (White Sands Missile Range) 1979 10 p Presented at the 2d Am. Electroplaters Soc. Symp. on Coating for Solar Collectors, St. Louis, 16 Oct. 1979

(Contract W-7405-eng-26)

(CONF-791021-3) Avail: NTIS: hiC A02/MF A01

Plasma-sprayed coatings on steel plates were tested at temperatures from 200 C to 1000 C. Analysis of the specimens before and after testing showed erbium dodecaboride, yttrium hexaboride, titanium diboride, and chromium oxide to be stable above 600 C. A heat balance on the water cooled specimens of these coatings showed 71% to 97% heat recovery efficiency.

N80-28876# Sandia Labs., Albuquerque, N. Mex. ANALYSIS OF THE INFLUENCE OF GEOGRAPHY AND WEATHER ON PARABOLIC TROUGH SOLAR COLLECTOR DESIGN

George W. Treadwell, Norman R. Grandjean, and Frank Biggs Mar. 1980 28 p refs

(Contracts EY-76-C-04-0789; DE-AC04-76DP-00789) (SAND-79-2032) Avail: NTIS HC A03/MF A01

The potential performance of single-axis tracking parabolic trough solar collectors as a function of optical energy distribution and receiver size was calculated for eleven sites using typical meteorological year input data. A simulation based on the SOLTES code was developed which includes the three dimensional features of a parabolic trough and calculates the thermo-optical tradeoffs. The capability of the thermo-optical model was confirmed by the comparison of calculated results with the experimental results from an all day test of a parabolic trough. The results from this eleven site analysis indicate a potential performance superiority of a north-south horizontal axis trough and, in addition, a high quality collector should be of the same geometric design for all of the sites investigated and probably for all regions of the country.

N80-28877# California Univ., Livermore. Lawrence Livermore

#### EFFECT OF A HEATED ATMOSPHERE ON THE EMITTANCE OF BLACK CHROME SOLAR COLLECTOR PIPE SUR-

Thomas A. Reitter and Warren H. Giedt (California Univ., Davis) 21 Mar. 1980 6 p refs Presented at Am. Section of Intern. Solar Energy Soc. Conf., Phoenix, Arix., 2-6 Jun. 1980 (Contract W-7405-eng-48)

(UCRL-83506: CONF-800604-6) Avail: NTIS

HC A02/MF A01

The total hemispherical emittance of the surfaces of solar collectors pipes was measured in the temperature range 100 to 300 C before and after exposure to heated humid or dry air atmosphere. The first exposure to heated air lowered the emittance of black chrome surface about 20%. Similar exposure increased the emittance of bare steel significantly, but had no effect on a nickel surface. Subsequent exposures to heated dry or humid air lowered the emittance of the black chrome surfaces by lesser amounts in what appeared to be a limiting process. In all cases, the emittance of the black chrome surfaces increased strongly with temperature. A possible explanation for the lowering of the black chrome emittance is the oxidation and subsequent outgassing of carbon contaminants in the black chrome coating.

N80-28879# Electric Power Research Inst., Palo Alto, Calif.
ELECTRIC UTILITY SOLAR ENERGY ACTIVITIES: ACTIVITIES: 1979 SURVEY Special Report, Dec. 1979

Robin Furness Dec. 1979 217 p (EPRI-ER-1299-SR) Avail: NTIS HC A10/MF A01

The results of surveys to determine the scope of solar energy projects sponsored by electric utilities in the United States are presented. It contains brief descriptions of 735 projects being conducted by 180 utility companies. Also included are an index of projects by category, a statistical summary, a list of participating utilities with information contacts and addresses, a list of utilities with projects designated by category, a list of utilities organized by state, and a list of available reports on utility-sponsored projects.

N80-28880# Alabama Univ. in Huntsville. Johnson Environment and Energy Center.

SOLAR ENERGY FOR BUILDINGS HANDBOOK

David L. Christensen Oct. 1979 268 p

(Contracts EG-77-S-05-5362; DE-AC05-77ET-20170)

(ORO-5362-T1) Avail: NTIS HC A12/MF A01

This handbook contains presentation materials and supporting text suitable for presentations, education, short courses, etc., for general audiences, as well as government officials and members of the building trade. The following are discussed: conservation, solar energy, economics, obstructions, and the future.

#### N80-28889# Ehrenkrantz Group, New York, N. Y. ACTIVE SÖLAR ENERGY SYSTEM DESIGN PRACTICE

Stephen D. Weinstein Oct. 1979 222 p Prepared in cooperation with Mueller Associates, Inc., Baltimore, Md. (Contract EG-77-C-01-2522)

(SOLAR/0802-79/01) Avail: NTIS HC A10/MF A01

This manual is divided into liquid and air systems. The following are covered: collectors, collector arrays, mounting and support, storage, dampers, leakage concerns, safety and protection, and other equipment.

#### N80-28890# Electric Power Research Inst., Palo Alto, Calif. MANUAL AND PROGRAMMABLE CALCULATOR METH-ODS FOR SIZING SOLAR ENERGY SYSTEMS

Robert S. Barlow Dec. 1979 79 p refs (EPRI-ER-1282-SR) Avail: NTIS HC A05/MF A01

The important characteristics, features, and limitations of manual methods and programmable calculator software for sizing active or passive solar energy systems and predicting their performance are described. The intent is to provide utilities with useful information that will facilitate sound choices of solar calculation methods to be used in responding to the National Energy Act. The major issues relating to manual solar calculation methods are discussed. General information on each method is given in easily used matrices. Critical reviews, as well as sources and costs, are given in a one page summary for each method. An effort is made to identify those methods that will be most useful, and overall conclusions are included. DOE

#### N80-28891# Los Alamos Scientific Lab., N. Mex. ENERGY SAVINGS OBTAINABLE THROUGH PASSIVE SOLAR TECHNIQUES

J. Douglas Balcomb 1980 13 p refs Presented at the Intern. Congr. on Bldg. Energy Management, Povoa de Varzim, Portugal, 12-16 May 1980 (Contract W-7405-eng-36)

CONF-800524-1) (LA-UR-80-746: Avail: NTIS

HC A02/MF A01

A survey of passive solar heating experience, especially in the US, is provided. Design approaches are reviewed and examples shown, Misconceptions are discussed. Advantages are listed. The Los Alamos program of performance simulation and evaluation is described and a simplified method of performance estimation is outlined. DOE

N80-28893# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

#### LONG-TERM AVERAGE PERFORMANCE BENEFITS OF PARABOLIC TROUGH IMPROVEMENTS

Randy Gee, Harry W. Gaul, David Kearney, and Ari Rabl Mar. 1980 40 p refs (Contract EG-77-C-01-4042)

(SERI/TR-632-439) Avail: NTIS HC A03/MF A01

Various technology advancements in improving the long term average performance of parabolic trough concentrating collectors were analyzed. The performance benefits of improvements are determined as a function of operating temperature for north-south, east-west, and polar mounted parabolic troughs. The results are presented graphically to allow a quick determination of the performance merits of particular improvements. Substantial annual energy gains are shown to be attainable. Of the improvements evaluated, the development of stable back-silvered glass reflective surfaces offers the largest performance gain for operating temperatures below 150 C. Above 150 C, the development of trough receivers that can maintain a vacuum is the most significant potential improvement. The reduction of concentrator slope errors also has a substantial performance benefit at high operating temperatures.

N80-28894# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

ANALYSIS OF SOLAR COLLECTOR ARRAY SYSTEMS USING THERMOGRAPHY

Anthony Eden Jan. 1980 50 p refs (Contract EG-77-C-01-4042)

(SERI/TR-351-494) Avail: NTIS HC A03/MF A01

The use of thermography to analyze large solar collector array systems under dynamic operating conditions is discussed. Thermographic techniques as well as equipment to determine temperature distributions, flow patterns, and air blockages in solar collectors are emphasized. The results illustrate the capabilities of infrared analysis as an analysis tool and operation and maintenance procedure when applied to large arrays. Thermographic analysis of most collector systems showed temperature distributions that indicated balanced flow patterns with both the thermographs and the hand held unit. In three significant cases, blocked or broken collector arrays, which previously had gone undetected, were discovered.

#### N80-28895# Boeing Aerospace Co., Seattle, Wash. EMERGING MATERIALS SYSTEMS FOR SOLAR CELL APPLICATIONS: Cu/SUB 2-X/Se

R. A. Mickelsen, J. M. Stewart, and W. S. Chen Feb. 1980 17 p refs

(Contract DE-AC04-79ET-23005)

(DOE/ET-23005-T3: QTPR-3) Avail: NTIS HC A02/MF A01 The feasibility of using Cu/sub 2-x/Se as a semiconductor material for the low cost production of photovoltaic solar cells was investigated. The Cu/sub 2-x/Se films were produced by coevaporation from individually monitored Cu and Se vapor sources. With a substrate temperature of 170 C, single phase cubic Cu/sub 2-x/Se films were produced. These films had a direct band gap of 2.2 eV and an indirect band gap of 1.4 eV. Both front wall and back wall cells were made. A theoretical computation on the thin film Cu/sub 2-x/Se/CdS cell has indicated an achievable efficiency of greater than 10%.

N80-28900# Oak Ridge National Lab., Tenn. Solar and Special

#### ROOF OVERHANG DESIGN FOR SOLAR CONTROL

Paul R. Barnes 1979 15 p refs Presented at the 4th Natl. Passive Solar Energy Conf., Kansas City, Kas., 3 Oct. 1979 (Contract W-7405-eng-26)

(CONF-791022-15) Avail: NTIS HC A02/MF A01

Design formulas are developed for both fixed and extendable overhangs as a function of window height, geographic latitude, and solar altitude. The extendable overhang is adjusted seasonally. Design parameters are suggested for near optimum solar control in direct gain passive systems. A method of estimating the effect of an overhang on solar gain is also developed. Examples of the solar performance for both fixed and adjustable overhangs are presented for 36 deg N latitude.

N80-28902# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

COST-EFFECTIVE WAYS TO IMPROVE THE FABRICATION AND INSTALLATION OF SOLAR HEATING AND COOLING SYSTEMS FOR RESIDENCES Final Report, 1 Jun. 1977 -30 Sep. 1978

Sanford B. Thayer, Peter Jacobs, and Norman Weaver Oct. 1978 134 p refs (Contract EG-77-S-02-4520)

(COO-4520-1) Avail: NTIS HC A07/MF A01

A study investigating cost effective ways of improving fabrication and installation of residential solar energy heating. systems is documented. The study entailed on-site observation of twelve installations focusing on the phase of mounting and manifolding of solar collectors. Time lapse photography and work measurement techniques were employed to record these installations. Generic collector types studied included air and liquid panels both internally and externally manifolded. Principal findings of the study synthesized from field observations, analysis of photographic data, time studies, and discussion with installation personnel and manufacturers' representatives are presented in the technical report.

N80-28905# Boston Univ., Mass. Dept. of Chemistry.
ORGANIC PHOTOCHEMICAL STORAGE OF SOLAR ENERGY Progress Report, 1 Feb. 1979 - 31 Jan. 1980 Guilford Jones, II Feb. 1980 17 p refs

(Contract EG-77-S-02-4380) (COO-4380-3) Avail: NTIS HC A02/MF A01

The quenching of fluorescent sensitizers by isomerizable substrates results in the formation of excited complexes. These sensitizer substrate pairs are highly polarized, leading to changes in bond order for the substrates. For several substrates this perturbation results in efficient valence isomerization. Isomerization observed on irradiation of charge transfer complexes of isomerizable substrates is consistent with a similar exciplex - template mechanism. The energy transfer mechanism of photosensitization was studied by measuring the temperature dependence of quantum yield for isomerization of dimethyl norbornadiene-2,3dicarboxylate sensitized by benzanthrone. From temperature and quencher concentration profiles quenching constants were obtained which are consistent with an endoergic triplet energy transfer mechanism. The thermal upconversion of the low energy triplet of benzanthrone results in a threefold increase in isomerization quantum yield over a 90 deg temperature range. DOE

N80-28908# Motorola, Inc., Scottsdale, Ariz. Government

LOW-COST PHOTOVOLTAIC CELL MOUNT STUDY Final Report

Albuquerque, N. Mex. Sandia Labs. Mar. 1980 65 p. (Contract EY-76-C-04-0789)

(SAND-80-7006) Avail: NTIS HC A04/MF A01

The development of a low cost photovolatic concentrator cell mount is described. A technical and economic evaluation of five-representative cell laydown techniques is given with the final goal being a determination of which was most promising from a cost performance basis. The five considered designs are representative of currently employed or proposed laydown techniques: (1) flexible adhesive hold down of the cell: (2) soldering the cell to a metallized alumina wafer; (3) soldering the cell to a plasma-sprayed copper and alumina substrate; (4) soldering the cell to a plasma-sprayed alumina/copper laminated substrate: and (5) soldering the cell to a metallized porcelain wafer. Tabular summaries are given for the economic and technical performance of each mounting technique. Conclusions are made concerning which design is most cost effective and comments on manufacturing and technical considerations of each mount are presented. Also, tests of an innovative heat dissipation system for passively cooling solar cells employing a reflux cooler panel based on the heat pipe concept are described. DOE

N80-28909# Los Angeles City Dept. of Water and Power, Calif SUN VALLEY PHOTOVOLTAIC POWER PROJECT, PHASE 1

Final Report, 1 Jun. 1978 - 28 Feb. 1979

Frank R. Goodman, Jr. Mar. 1980 166 p refs (Contract ET-78-C-04-4281)

(ALO-4281-1) Avail: NTIS HC A08/MF A01

An application experiment was devised for fabrication installation, operation, and evaluation of a concentrating photovoltaic system for direct conversion of sunlight to electricity. The photovoltaic system was connected to an electric motor load and to an electric utility system. Provisions were made to allow the motor load to be supplied with power from either the photovoltaic system or the utility system. When the demand of the motor load was low, the photovoltaic system delivered excess power to the utility system for use elsewhere. Thus, the experimental installation was designed with sufficient flexibility to enable several modes of operation to be evaluated. DOE

N80-28912# Edgerton, Germeshausen and Grier, Inc., Albuquer-

CONCENTRATING SOLAR COLLECTOR TEST RESULTS Vernon E. Dudley and Robert M. Workhoven 1980 5 p refs Presented at the Am. Sect. of the Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2 Jun. 1980 Prepared in cooperation with Sandia Labs., Albuquerque, N. Mex.

(Contract EY-76-C-04-0789)

(SAND-80-0801C; CONF-800604-5)

Avail: NTIS

HC A02/MF A01

Some of the results obtained from three years of testing concentrating solar collectors at Sandia National Laboratories are summarized. Efficiency and thermal loss test data is for 16 collectors from 11 different manufacturers.

N80-28928# Ueland and Junker, Architects and Planners, Philadelphia, Pa.

SOLAR ATRIUM: A HYBRID SOLAR HEATING AND COOLING SYSTEM Technical Progress Report, 19 Dec. 1978 - 19 Mar. 1979

Mark Ueland 19 Mar. 1979 11 p

(Contract EG-77-G-04-4135)

(DOE/CS-34135/6: TPR-6) Avail: NTIS HC A02/MF A01 The design, construction and monitoring of an innovative concept of solar heating and cooling are described. The concept is adaptable to residences and smaller commercial and institutional buildings. It is designed to be constructed of materials and equipment that are economical and readily available. Progress on construction is reported.

N80-28936# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics. AN INVESTIGATION OF WIND LOADS ON SOLAR **COLLECTORS** Final Report

H. W. Tieleman, R. E. Akins, and P. R. Sparks Jan. 1980 169 p refs

(Contract EO-A01-78-3605)

(PB80-158744; VPI-E-80-1) Avail: NTIS HC A08/MF A01; also available in set of 3 reports HC E14, PB80-158736 CSCL

A wind-tunnel study of a series of model solar collector installations (flat-plate collectors) immersed in a thick turbulent shear layer was undertaken in order to determine design wind loads on such installations. Wind tunnel measurements were made of the mean and fluctuating pressures on a model of a single flat-plate collector which was a component of different multi-panel installations. The pressures were spatially integrated over the top and bottom surface of the single collector separate-

N80-28937# Virginia Polytechnic Inst. and State Univ., Dept. of Engineering Science and Mechanics. Blacksburg. AN INVESTIGATION OF WIND LOADS ON SOLAR COLLECTORS. APPENDIX 1: DATA LISTING FOR TOP AND BOTTOM OF COLLECTOR Final Report

H. W. Tieleman, R. E. Akins, and P. R. Sparks Jan. 1980 312 p refs

(Contract EO-A01-78-3605)

(PB80-158751: VPI-E-80-1-App-1) Avail: HC A14/MF A01; also available in set of 3 reports HC E14, PB80-158736 CSCL 10A

A wind-tunnel study of a series of model solar-collector installations (flat-plate collectors) immersed in a thick turbulent shear layout was undertaken in order to determine design wind toads on such installations. The complete results of all wind tunnel model tests are presented in tabular and graphical form.

N80-28947# Automation Industries, Inc., Silver Spring, Md. Vitro Labs. Div.

ENVIRONMENTAL DATA FOR SITES IN THE NATIONAL SOLAR DATA NETWORK

Dec. 1979 218 p refs

(Contract DE-AC01-79CS-30027)

(SOLAR/0010-79/12) Avail: NTIS HC A10/MF A01

Environmental information collected at each of the sites for the reporting month are tabulated. Data included are insolation, temperature, wind, and relative humidity. These data are for use in determining the thermal performance of the solar systems. DOE (MHR).

N80-29505# General Atomic Co., San Diego, Calif. SOLAROIL PROJECT. PHASE 1: PRELIMINARY DESIGN REPORT

#### 02 SOLAR ENERGY

G. Baccaglini, J. Bass, J. Neill; V. Nicolayeff, and F. Openshaw Mar. 1980 439 p refs (Contract DE-AC03-79CS-30308; GA Proj. 3315)

(GA-A-15823) Avail: NTIS HC A19/MF A01

The Solar Thermal Enhance Oil Recovery (Solar Oil) Plant is designed to demonstrate that using solar thermal energy is technically feasible and economically viable in enhanced oil recovery. The plant uses the fixed mirror solar concentrator to heat high thermal capacity oil to 322 C (611 F). The hot fluid is pumped from a hot oil storage tank (20 min capacity) through a once through steam generator which produces 4.8 MPa (700 psi) steam at 80% quality. The plant net output, average over 24 hr/day for 365 day/yr, is equivalent to that of a 2.4 MW (8.33 x 10 to the 6 power Btu/hr) oil fired steam generator having a 86% availability. The net plant efficiency is 57.3% at equinox noon, a 30%/yr average. The plant will be demonstrated at an oilfield site near Oildale, California.

## N80-29532# Naval Civil Engineering Lab., Port Hueneme, Calif. SOLAR HEATING OF BUILDINGS AND DOMESTIC HOT WATER

Edward R. Durlak May 1980 182 p refs (AD-A085815; CEL-TR-877) Avail: NTIS HC A09/MF A01 CSCL 13/1

This report presents design criteria and cost analysis for methods for the sizing and justification of solar heat collectors for potable water heaters and space heaters. Sufficient information is presented to enable engineers to design solar space and water heating systems or conduct basic feasibility studies preparatory to design of large installations. Both retrofit and new installations are considered. This report has been substantially revised from the previous edition Beck and Field, 1977. However, most of the revision is in Section 2.0, where more material of an exploratory nature has been added. Section 3.0, which contains the calculation method and worksheets, is largely the same, except that the economic analysis has been revised and new tables have been added to provide a self-contained source of meteorological data and collector test data.

N80-29534# - National Bureau of Standards, Washington, D.C. National Engineering Lab.

SIMPLIFIED ENERGY DESIGN ECONOMICS: PRINCIPLES OF ECONOMICS APPLIED TO ENERGY CONSERVATION AND SOLAR ENERGY INVESTMENTS IN BUILDINGS Final Report

Harold E. Marshall, Rosalie T. Ruegg, and Forest Wilson Jan.

(PB80-179245; NBS-SP-544) Avail: NTIS HC A04/MF A01 CSCL 13A

Economic analysis techniques for evaluating alternative energy conservation investments in buildings are presented. Life cycle cost, benefit cost, savings to investment, payback, and rate of return analyses are explained and illustrated. The procedure for discounting is described for a heat pump investment. Formulas, tables of discount factors, and detailed instructions are provided to give all information required to make economic evaluations of energy conserving building designs.

# N80-29537# Swedish Council for Building Research, Stockholm. REPORTING FORMAT FOR THERMAL PERFORMANCE OF SOLAR HEATING AND COOLING SYSTEMS IN BUILDINGS

Per Isakson (Royal Inst. of Tech.), William Kennish (TPI, Inc.), and Egil Ofverholm (Royal Inst. of Tech.) Feb. 1980 60 p refs

(PB80-175375; D1-1980; ISBN-91-540-3157-5) Avail: NTIS HC A04/MF A01 CSCL 13A

The performance of solar testing and cooling systems and the cost effectiveness of these systems is considered. Common procedures for predicting, measuring, and reporting the thermal performance of systems and methods for designing economical optimized systems are discussed.

N80-29835\* National Aeronautics and Space Administration. Pasadena Office, Calif.

## INDUCED JUNCTION SOLAR CELL AND METHOD OF FABRICATION Patent

Joseph Maserjian (JPL), Shy Shiun Chern (JPL), and Seung P. Li, inventors (to NASA) (JPL) Issued 16 May 1978 9 p Filed 15 Jun. 1976 Sponsored by NASA

(NASA-Case-NPO-13786-1; US-Patent-4,090,213;

US-Patent-Appl-SN-696374; US-Patent-Class-357-30;

US-Patent-Class-357-52; US-Patent-Class-357-91;

US-Patent-CLass-148-1.5) Avail: US Patent and Trademark Office CSCL 10A

An induced junction solar cell is fabricated on a p-type silicon substrate by first diffusing a grid of criss-crossed current collecting n+ stripes and thermally growing a thin SiO2 film, and then, using silicon-rich chemical vapor deposition (CVD), producing a layer of SiO2 having inherent defects, such as silicon interstices, which function as deep traps for spontaneous positive charges. Ion implantation increases the stable positive charge distribution for a greater inversion layer in the p-type silicon near the surface. After etching through the oxide to parallel collecting stripes, a pattern of metal is produced consisting of a set of contact stripes over the exposed collecting stripes and a diamond shaped pattern which functions as a current collection bus. Then the reverse side is metallized.

Official Gazette of the U.S. Patent and Trademark Office

N80-29843\*# National Aeronautics and Space Administration. Pasadena Office, Calif. 1

AUTOMOTIVE ABSORPTION AIR CONDITIONER UTILIZING SOLAR AND MOTOR WASTE HEAT Patent Application

Zenon Popinski, inventor (to NASA) (JPL) Filed 30 Jul. 1980 15 p

(Contract NAS7-100)

(NASA-Case-NPO-15183; US-Patent-Appl-SN-173519) Avail: NTIS HC A02/MF A01 CSCL 10A

An absorption cycle air conditioning system for use as a space cooling system in an electrically powered motor vehicle is disclosed. The system is of a lightweight design and has a capability for achieving vehicular space cooling with minimal attendant power requirements. The system is adapted to utilize solar and motor waste heat.

# N80-29846\*# Travis-Braun and Associates, Inc., Dallas, Tex. SOLAR HEATING AND HOT WATER SYSTEM INSTALLED AT OFFICE BUILDING, ONE SOLAR PLACE, DALLAS, TEXAS Final Report

Jun. 1980 123 p (Contract EG-77-A-01-4093)

(NASA-CR-161483) Avail: NTIS HC A06/MF A01 CSCL

A solar heating on cooling system is described which is designed to provide 87 percent of the space heating needs, 100 percent of the potable hot water needs and is sized for future absorption cooling. The collection subsystem consists of 28 solargenics, series 76, flat plate collectors with a total area of 1,596 square feet. The solar loop circulates an ethylene glyco water solution through the collectors into a hot water system exchanger. The water storage subsystem consists of a heat exchanger, two 2,300 gallon concrete hot water storage tanks with built in heat exchangers and a back-up electric boiler. The domestic hot water subsystem sends hot water to the 10, 200 square feet floor area office building hot water water fixtures. The building cold water system provides make up to the solar loop, the heating loop, and the hot water concrete storage tanks. The design, construction, cost analysis, operation and maintenance of the solar system are described. R.C.T.

N80-29847\*# Dallas Independent School District, Tex.
SOLAR HEATING AND DOMESTIC HOT WATER SYSTEM
INSTALLED AT NORTH DALLAS HIGH SCHOOL Final
Report

May 1980 106 p

(Contract EM-78-F-01-5204)

(NASA-CR-161482) Avail: NTIS HC A06/MF A01 CSCL 108

The solar energy system located at the North Dallas High School, Dallas, Texas is discussed. The system is designed as a retrofit in a three story with basement, concrete frame high school building. Extracts from the site files, specification references for solar modification to existing building heating and domestic hot water systems, drawings, installation, operation and maintenance instructions are included. R.C.T.

N80-29848\* Citizens Mutual Savings and Loan Association, Leavenworth, Kans.

SOLAR HEATING AND COOLING SYSTEM INSTALLED AT LEAVENWORTH, KANSAS Final Report

Jun. 1980 318 p

(EM-78-F-01-5193)

(NASA-CR-161484) Avail: NTIS HC A14/MF A01 CSCL

A solar heating and cooling is described which is designed to furnish 90 percent of the overall heating load, 70 percent of the cooling load and 100 percent of the domestic hot water load. The building has two floors with a total of 12,000 square feet gross area. The system has 120 flat-plate liquid solar panels with a net area of 2,200 square feet. Five 3 ton Arkla solar assisted absorption units provide the cooling, in conjunction with a 3,000 gallon chilled water storage tank. Two 3,000 gallon storage tanks are provided with one designated for summer use, whereas both tanks are utilized during winter. R.C.T.

N80-29849\* # Stephens Coll., Columbia, Mo. **Building** and Grounds Dept.

SOLAR SPACE HEATING FOR THE VISITORS CENTER, STEPHENS COLLEGE, COLUMBIA, MISSOURI Final

Jun. 1980 310 p

(Contract EG-77-A-01-4084)

(NASA-CR-161485) Avail: NTIS HC A14/MF A01 CSCL 10B

The solar energy system located at the Visitors' Center on the Stephens College Campus, Columbia, Missouri is discussed. The system is installed in a four-story, 15,000 square foot building. The solar energy system is an integral design of the building and utilizes 176 hydronic flat plate collectors which use a 50 percent water ethylene blycol solution and water-to-water heat exchanger. Solar heated water is stored in a 5,000 gallon water storage tank located in the basement equipment room. A natural gas fired hot water boiler supplies hot water when the solar energy heat supply fails to meet the demand. The designed solar contribution is 71 percent of the heating load.

N80-29850\*# IBM Federal Systems Div., Huntsville, Ala. SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION. SEASONAL REPORT FOR COLT PUEBLO, PUEBLO, COLORADO Contractor Report, Feb. 1979 - Jan. 1980 Jun. 1980 93 p refs Sponsored in part by DOE (Contract NAS8-32036).

(NASA-CR-161493) Avail: NTIS HC A05/MF A01 CSCL 10B

The Colt-Pueblo solar energy system, designed to provide space heating and hot water preheating, is described and its operational performance for a 12 month period from February 1979 through January 1980 is evaluated. The space heating subsystem met 31 percent of the measured space heating load which was close to the expected 34 percent solar fraction. Although the hot water solar fraction was 79 percent, the overall energy saving capability was reduced because of the low hot water demand. The measured heating subsystem performance would have improved considerably if the uncontrolled losses primarily from transport piping could have been reduced to an inconsequencital level. Fossil energy savings of 70.31 million BTUs are estimated.

N80-29851\*# IBM Federal Systems Div., Huntsville, Ala. SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION. SEASONAL REPORT FOR SEECO LINCOLN, LINCOLN, NEBRASKA Contractor Report, Apr. 1979 - Mar. 1980 Jun. 1980 71 p refs Sponsored in part by DOE (Contract NAS8-32036)

(NASA-CR-161495) Avail: NTIS HC A04/MF A01, CSCL 10B

The Solar Engineering and Equipment Company (SEECO) Lincoln solar energy system, designed for space heating only, is described and its operational performance for a 12 month period from April 1979 through March 1980 is evaluated. The system met 27 percent of the space heating load; however, system losses into the heated space from the storage bin and ductwork were significant. Reducing these losses would add appreciably to the system's efficiency. Net fossil energy savings were 11.31 million BTUs.

N80-29853\*# IBM Federal Systems Div., Huntsville, Ala. SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR CONTEMPORARY NEWMAN, NEWMAN, GEORGIA Contractor Report, Jun. 1979 - Apr. 1980

Jun. 1980 80 p Sponsored in part by DOE (Contract NAS8-32036)

(NASA-CR-161494) Avail: NTIS HC A05/MF A01

A hot solar heating and hot water system's operational performance from June 1979 through April 1980 is evaluated. Solar energy satisfied 42 percent of the total measure load (hot water plus space heating), which was somewhat higher than the solar fraction of 32 percent. When system losses into the heating space from duct leaks and storage are included, the heating solar fraction increases from 42 to 64 percent. Net electrical energy savings were 5.47 million BTUs.

N80-29854\*# IBM Federal Systems Div., Huntsville, Ala. SOLAR ENERGY SYSTEM ECONOMIC EVALUATION: IBM SYSTEM 2, TOGUS, MAINE Final Report

Jul. 1980 95 p refs Sponsored in part by DOE (Contract NAS8-32036)

(ÑASA-CR-161510) Avail: NTIS HC A05/MF A01

The economic analysis of the solar energy system, is developed for Torgus and four other sites typical of a wide range of environmental and economic conditions in the continental United States. This analysis is accomplished based on the technical and economic models in the f-chart design procedure with inputs taken on the characteristics of the installed system and local conditions. The results are expressed in terms of the economic parameters of present worth of system cost over a projected twenty year life, life cycle savings, year of positive savings and year of payback for the optimized solar energy system at each of the analysis sites. The sensitivity of the economic evaluation to uncertainties in constituent system and economic variables is also investigated. Results demonstrate that the solar energy system is economically viable at all of the five sites for which the analysis was conducted.

N80-29855\*# IBM Federal Systems Div., Huntsville, Ala. SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR FERN LANSING, LANSING, MICHIGAN Contractor Report, Apr. 1979 - Mar. 1980 Jun. 1980 87 p Sponsored in part by DOE

(Contract NAS8-32036)

(NASA-CR-161491) Avail: NTIS HC A05/MF A01, CSCL

A solar space heating and hot water system's operational performance from April 1979 through March 1980 is evaluated. Solar energy satisfied 15 percent of the total measured load (hot water plus space heating). Net savings were approximately 21 million BTUs.

N80-29856\*# IBM Federal Systems Div., Huntsville, Ala. SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR IBM SYSTEM 1B, CARLSBAD, NEW MEXICO Contractor Report, Apr. 1979 - Mar. 1980 Jul. 1980 75 p refs Sponsored in part by DOE (Contract NAS8-32036)

(NASA-CR-161508) Avail: NTIS HC A04/MF A01 CSCL

A hot solar heating and hot water system's operational

#### **02 SOLAR ENERGY**

performance from April 1979 through March 1980 is evaluated. The space heating and hot water loads were near expected values for the year. Solar energy provided 43 percent of the space heating and 53 percent of the hot water energy. The system did not meet the total system solar fraction design value of 69 percent because of a combination of higher estimated space heating load than was actually encountered and the apportioning of solar energy between the space heating and the domestic hot water loads. System losses and high building temperatures also contributed to this deviation. Total net savings were 23.072 million BTUs. Most of the energy savings came during the winter months, but hot water savings were sufficient to justify running the system during the summer months. LF.M.

N80-29858\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. 'Solar Thermal Power Systems.

ELECTROCHEMICAL ENERGY STORAGE SYSTEMS FOR SOLAR THERMAL APPLICATIONS

S. Krauthamer and H. Frank 1 Mar. 1980 119 p refs Revised

(Contracts NAS7-100; DE-AI01-79ET-20307)

(NASA-CR-163432; JPL-Pub-79-95-Rev-1;

DOE/JPL-1060/30-Rev-1) Avail: NTIS HC A06/MF A01 CSCL 10C

Existing and advanced electrochemical storage and inversion/conversion systems that may be used with terrestrial solar-thermal power systems are evaluated. The status, cost and performance of existing storage systems are assessed, and the cost, performance, and availability of advanced systems are projected. A prime consideration is the cost of delivered energy from plants utilizing electrochemical storage. Results indicate that the five most attractive electrochemical storage systems are the: iron-chromium redox (NASA LeRC), zinc-bromine (Exxon), sodium-sulfur (Ford), sodium-sulfur (Dow), and zinc-chlorine (EDA).

A.R.H.

URBAN SOLAR PHOTOVOLTAICS POTENTIAL: AN INVENTORY AND MODELLING STUDY APPLIED TO THE SAN FERNANDO VALLEY REGION OF LOS ANGELES

G. L. Angelici, N. A. Bryant, R. K. Freta, and S. Z. Friedman 15 Aug. 1980 47 p refs (Contract NAS7-100)

(NASA-CR-163436; JPL-PUB-80-43) Avail: NTIS HC A03/MF A01 CSCL 10A

Procedures for analyzing the potential of solar photovoltaic collectors to meet energy requirements in a metropolitan region are described and a modeling effort is applied to the San Fernando Valley region of Los Angeles. The procedure involves a series of steps designed to produce maps and tabulations revealing the amount of rooftop area available for establishing solar collectors and the proportion of energy requirement that could be potentially supplied by solar photovoltaics within each of the 533 mainline feeder service areas in the study area. For the sixty five square mile study area, the results showed that, with half the available flat and south facing roofs used and assuming the availability of energy storage, 52.7 percent of the actual kWh energy requirements could have been met in 1978 using photovoltaic collectors. Hourly, daily, weekly, and monthly fluctuations in potential supply and actual loads and recommendations of avenues for further research are discussed. Some further potential applications of the modeling technique are suggested.

N80-29864# Army Construction Engineering Research Lab., Champaign, III.

INVESTIGATION OF METHODS TO PREDICT THERMAL STRATIFICATION AND ITS EFFECT ON SOLAR ENERGY SYSTEM PERFORMANCE

B. J. Sliwinski May 1980 33 p refs

(DA Proj. 4A7-61102-AT-23)

(AD-A086051; CERL-SR-E-160)

HC A03/MF A01 CSCL 10/2

Avail: NTIS

This report describes a study to identify characteristics which induce thermal stratification in liquid thermal storage, and to evaluate solar energy system performance as a function of the

degree of stratification. It was determined that for efficient use of thermal stratification it was necessary to (1) introduce hot fluid at the top of the liquid storage tank to add cold fluid at the bottom of the tank, (2) with a cylindrical tank, have a length/diameter ratio equal to or greater than 2.0, (3) use mathematical correlations to determine allowable fluid inlet velocities and temperatures, and (4) use storage tank material that has a thermal conductivity less than that of the storage fluid. The mathematical correlations described in this report allow stratification occurrence to be predicted and can be used to estimate the sharpness of the thermocline based on tank inlet and outlet conditions, fluid properties, and storage tank geometry.

N80-29867# Brookhaven National Lab., Upton, N. Y. Solar Technology Group.

GROUND COUPLED SOLAR HEAT PUMP RESEARCH PROGRAM IN THE UNITED STATES

Philip D. Metz 1980 5 p refs Presented at the 5th Ann. Heat Pump Technol. Conf., Stillwater, Okla., 14-15 Apr. 1980 (Contract EY-76-C-02-0016)

(BNL-27383; CONF-800451-1) Avail:

HC A02/MF A01

The ground coupling research program funded by the Systems Development Division of the Office of Solar Applications of the US Department of Energy studies the use of the Earth as a heat source/sink or storage element for solar heat pump space conditioning systems. The goal of this research program is to determine the feasibility of ground coupling, and if feasibility is confirmed, to create handbooks which facilitate widespread application of ground coupling. The research program is outlined and the research projects currently in progress and how they fit into the program are described. Progress toward the program goal is evaluated.

N80-29870# Solar Turbines International, San Diego, Calif.
DEVELOPMENT OF POLYIMIDE MATERIALS FOR USE IN
SOLAR ENERGY SYSTEMS Final Report, 1 Aug. 1978
31 Jul. 1979

A. L. Wilcoxson, U. A. Sorathia, and J. Gagliani 1980 61 p

(Contracts EM-78-C-04-5305; DE-AS04-78CS-35305) (DOE/CS-35305/T2) Avail: NTIS HC A04/MF A01

A program to optimize and characterize improved insulation materials for solar energy systems is described. Two separate and distinct products have been studied, a lightweight flexible insulating foam and a high density, rigid, load bearing insulating foam. These products are derived from a polyimide resin, the formulations and processes for which were developed under NASA-JSC sponsored programs. These materials are nonburning and do not emit measurable quantities of smoke or toxic by-products. Candidate resins were selected on the basis of cost, expected foam insulating and weatherability properties and ease of production. Critical characterization parameters were established for the flexible insulating foam in the form of environmental exposure resistance, thermal conductivity and hydrolytic stability. Studies initiated to improve the exposure resistance included additive studies, using reinforcements and UV absorbers, and postcure and densification studies. Optimum resin formulations, foam densities and foam structures were identified on the basis of the exposure, thermal conductivity, and microwave testing.

N80-29871# American Science and Engineering, Inc., Cambridge, Mass.

DOE

DEVELOPMENT OF A SECOND GENERATION CONCENTRATING TRACKING SOLAR COLLECTOR Final Report, 19 Jun. - 31 Oct. 1979

31 Mar. 1980 10 p

(Contract EM-78-C-04-4275)

(ASE-4524) Avail: NTIS HC A02/MF A01

Results are presented of testing done on the Second Generation Concentrating Tracking Solar Collector. This includes testing of both the single tube collector shown in Figure 1 and the 4' x 8' collector shown in Figure 2. The testing was performed between April 1979 and February 1980 under various conditions.

Air conditions included clear air, haze and smog, and ambient temperature varied widely. The diversity of testing conditions provided a realistic evaluation of collector performance.

N80-29872# Midwest Research Inst., Golden, Colo. Solar Thermal Research Branch.

ANALYSIS OF THE OMNIUM G RECEIVER

Mark Bohn Mar. 1980 31 p refs (Contract EG-77-C-01-4042)

(SERI/TR-631-387) Avail: NTIS HC A03/MF A01

A thermal analysis of the Omnium-G receiver is presented and the technique is shown to be generally applicable to solar thermal receivers utilizing a directly heated thermal mass. The thermal loss coefficient, including reradiation losses, is calculated and shown to agree quite well with the experimentally measured thermal loss coefficient. The rate of heat transfer to the working fluid is also analyzed and the analysis is used to show that the Omnium-G receiver is well matched to the water/steam working fluid because the steam outlet temperature is almost the same as the receiver temperature. A general procedure for calculating receiver performance is presented. With this procedure, the energy delivery to any working fluid, the delivered temperature of the working fluid, and the pressure drop through the receiver can be determined. An example of the calculation is also presented. DOE

N80-29873# University of Southern California, Los Angeles. Dept. of Materials Science.

LOW COST SOLAR CELLS BASED ON AMORPHOUS SILICON ELECTRODEPOSITED FROM ORGANIC SOL-VENTS Technical Quarterly Progress Report, 1 Mar. - 31 May 1979

F. A. Kroger 1980 31 p (Contract EY-76-S-03-0113)

(SAN-0113-040-T7; TQPR-3) Avail: NTIS HC A03/MF A01 Electrolysis experiments were carried out using tetra ethyl ortho silicate plus propylene carbonate or 1-chloropropane or acetic acid or formamide and ammonium hexafluorosilicate plus formamide. These experiments yielded deposits which vary in color between white and black with greyish white, light or dark brown as intermediate colors depending on the deposition conditions. Energy dispersive X-ray analysis in the scanning electron microscope indicated the deposits to contain large concentrations of silicon; infrared absorption and reflection studied showed bands characteristics of Si-O, Si-Cl or Si-F vibrations and this indicates the presence of these elements in the films. Determination of carrier type in doped deposits by hot point probe method was not successful.

480-29875# California Univ., Livermore. Lawrence Livermore

REACTIVELY SPUTTERED THIN FILM Cu/sub x/S/CdS PHOTOVOLTAIC DEVICES Final Progress Report, 1 Oct. 1978 - 30 Sep. 1979

L. D. Partain, G. A. Armantrout, J. H. Yee, J. Y. Leong, and D. OKubo 2 Apr. 1980 162 p refs (Contract W-7405-eng-48)

(UCID-18592) Avail: NTIS HC A08/MF A01

Properties not explained by standard theory are well modeled by space-charge-limited current analysis. Extension of the SEM electron beam induced current techniques coupled with the material fabrications obtained with sputtering allowed rather complete characterizations of thin film devices for the first time. These included the minority and majority carrier transport parameters and the optical properties and indicated that unanticipated parameters determine performance and control repeatability and should establish device stability limits. The junction region losses of minority carrier current are identified as a dominant effect of heat treatment and actual junction collection efficiency values are quantified. Sputtering allowed free standing, polycrystalline Cu/sub x/S films to be formed on glass for clear determinations of charge transport and optical properties in addition to providing a highly planar geometry on the CdS substrates required for the SEM studies. DOE

N80-29876# General Electric Co., Philadelphia, Pa. Forge Space Center.

DESIGN OF A PHOTOVOLTAIC SYSTEM FOR A SOUTH-WEST ALL-ELECTRIC RESIDENCE

E. M. Mehalick, G. Obrien, G. F. Tully, J. Johnson, and J. Parker Apr. 1980 220 p refs

(Contract EY-76-C-04-0789)

(SAND-79-7056) Avail: NTIS HC A14/MF A01

The grid connected residential photovoltaic system for the Southwest is designed to meet both space conditioning requirements and all conventional electrical load requirements for an all-electric residence. The system is comprised of two major subsystems, the solar array and the power conditioning subsystem (PCS). An 8 kW peak photovoltaic array been designed for the house. The 93 square meters solar array uses a shingle solar cell module in a highly redundant series/parallel matrix. The photovoltaic generated power is supplied to a 10kVA power conversion subsystem which is controlled to track the solar array maximum power operating point and feed the 240 Vac output power directly to the house loads or back to the utility when excess power is generated. The photovoltaic power is isolated from the utility by a 15 kVA transformer. The house design and subsystem specifications are given in detail.

N80-29877# Commission of the European Communities, Ispra (Italy). Joint Research Center.

STANDARD PROCEDURES FOR TERRESTRIAL PHOTOVOL-TAIC PERFORMANCE MEASUREMENTS: SPECIFICATION NO. 101

1979 40 p

(EUR-6423EN) Avail: NTIS HC A03/MF A01

Since the response of a solar cell is wavelength-dependent, its performance is significantly affected by the spectral energy distribution of the radiation, which in the case of natural sunlight varies with location, weather, time of year, and time of day. If the irradiance is measured with a thermopile-type radiometer, which is not spectrally selective, rated power measurements can vary by as much as 15% from day to day at the same place. The procedures are designed to minimize such discrepancies by relating the performance to a standard terrestrial solar spectral energy distribution, hereafter referred to as standard sunlight. This is done by measuring irradiance with a reference solar cell or module which has been calibrated at 25 + or -2 C in terms of short circuit current per unit of standard sunlight irradiance by an approved Solar Cell Calibration Agency. The reference cell automatically takes account of variation in spectral distribution. If the performance of a cell, module or array is related to a known standard sunlight distribution, it is possible to compute within a reasonable tolerance its performance in light or any other known spectral energy distribution. DOE

N80-29878# European Space Research and Technology Center, Noordwijk (Netherlands).

EUROPEAN TECHNOLOGY APPLICABLE TO SOLAR POWER SATELLITE SYSTEMS (SPS)

H. Stoewer 1979 24 p refs Presented at the 30th Congr. of the Intern. Astronautical Federation, Munich, 16 Sep. 1979 (INKA-Conf-79-378-046; CONF-7909124-1; IAF-79-174) Avail: NTIS (US Sales Only) HC A02/MF A01; DOE Depository

The Solar Power Satellite System (SPS) stands for a concept which is intended to collect energy in Earth orbit, transmit it to the Earth and convert it on the ground into electric energy. This paper summarizes European space technology activities that might have potential for application in a possible future Solar Power Satellite System (SPS) program. Before a decision in favor of or against an SPS development program can be made, several critical technology areas must be investigated in order to assess with a reasonable degree of confidence the potential benefits, cost and development risks associated with an SPS. Existing and developing European space technologies are compared with the expected requirements of a study assessment and early key technology verification investigations for SPS concept. It is shown that a number of existing European space technologies and the results of current development efforts apply well to this. However, very substantial advances in almost all technological areas will be

necessary before a prudent decision for implementation of an SPS can be made. DOE

N80-29879# Motorola, Inc., Phoenix, Ariz. Solar Energy. Dept.

THIN FILM POLYCRYSTALLINE SILICON SOLAR CELLS Final Report, 26 Sep. 1978 - 25 Sep. 1979

K. R. Sarma, M. J. Rice, R. Legge, R. W. Gurtler, and W. C. Ramsey 1 Dec. 1979 93 p refs (Contract ET-78-C-03-2207)

(SAN-2207-T4) Avail: NTIS HC A05/MF A01

Methods of depositing thin polycrystalline silicon films, utilizing an energy beam, for producing solar cells capable of meeting long range economic and performance objectives are discussed. Progress is reported in detail on the (1) investigation of the energy beam as a means for efficient, high-rate deposition of polysilicon films; (2) development of temporary, reusable substrates for polysilicon deposition; (3) subsequent grain enhancement of self-supporting thin silicon films through laser recrystallization; and (4) demonstration of at least 10 percent efficient solar cells fabricated on these grain enhanced silicon films.

## N80-29880# General Accounting Office, Washington, D. C. THE 20 PERCENT SOLAR ENERGY GOAL: IS THERE A PLAN TO ATTAIN IT?

E. B. Staats 31 Mar. 1980 15 p refs (EMD-80-64) Avail: General Accounting Office, Washington, D.C.

The Administration's efforts, primarily those of the Department of Energy, to attain the goal of meeting 20% of the Nation's energy needs from solar resources by the year 2000 are reviewed. It was observed that while the President called for several legislative initiatives and the creation of a Solar Subcommittee, actions on them are underway, but none have yet been finalized.

## N80-29881# Brookhaven National Lab., Upton, N. Y. PHOTOVOLTAIC/THERMAL HYBRID PROJECTS

Edward A. Kush 1980 5 p refs Presented at the Ann. DOE Active Solar Heating and Cooling Contractors' Rev. Meeting, Incline, Nev., 26-28 Mar. 1980

(Contracts EY-76-C-02-0016; DE-AC02-76CH-00016) (BNL-27669) Avail: NTIS HC A02/MF A01

Systems which utilize a combination of photovoltaic and thermal collection in the same solar collectors (PV/T Systems) can have advantages over PV or thermal only systems in that the cost effectiveness of the collectors and their support structure may be improved, active cooling may allow the cells to run at lower temperatures-hence higher conversion efficiency, and space limitations on side by side collectors can be avoided. Evaluation of such systems requires formulation and assessment of collector concepts, power conditioning, storage, and control strategies, and their interactions when combined into a total system. Systems with flat plate PV/T collectors and vapor compression heat pump driven by the photovoltaic electric output are considered along with PV/T concentrating collectors and their potential applications, particularly to solar driven absorption chillers.

N80-29882# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

### USER EVALUATION STUDY OF PASSIVE SOLAR RESIDENCES

Sharyn Towle Mar. 1980 6 p Presented at the 4th Natl. Passive Solar Energy Conf., Kansas City, Kas., 3-5 Oct. 1979 (Contract EG-77-C-01-4042)

(SERI/TP-63-350: CONF-791022-16) Avail: NTIS HC A02/MF A01

The readiness of various passive solar energy techniques for commercialization and market potential for residential applications is assessed. The preliminary findings of a market assessment study designed to document user experiences with passive solar energy are discussed. Owners and builders of passive solar homes were interviewed and asked to comment on personal experiences with their homes.

N80-29883# Suntek Research Associates. Corte Madera. Calif. ENGINEERING DESIGN FOR THERMOCRETE CENTRAL STORAGE UNITS FOR LOW TEMPERATURE SOLAR APPLICATION Final Report

1979 11 p refs

(Contract DE-AC02-78CS-34702)

(DOE/CS-34702/4) Avail: NTIS HC A02/MF A01

The overall objective was to produce a set of value-engineered blueprints for mass-produced modular phase-change thermal storage units. As a result of the failure of Thermocrete samples during thermal evaluation, DOE project management and Suntek agreed that work on Thermocrete should be stopped at the end of September 1978, and that work should commence on incorporating Heat Mirror transparent insulation into windows and skylights. Since work on Thermocrete was stopped at approximately 20 percent complete, no blueprints were produced nor were any firm conclusions reached. The technical report outlines briefly the status of each section of work statement when the project was stopped.

N80-29884# Oak Ridge National Lab., Tenn, Solar and Special Studies Station.

## PASSIVE SOLAR HEATING AND NATURAL COOLING OF AN EARTH-INTEGRATED DESIGN

Paul R. Barnes and Hanna B. Shapira 1980 7 p refs. Presented at the Natl. Tech. Conf. on Earth Sheltered Building Design Innovations, Oklahoma City, 18 Apr. 1980 (Contract W-7405-eng-26)

(CONF-800449-1) Avail: NTIS HC A02/MF A01

The Joint Institute for Heavy Ion Research is being designed with innovative features that will greatly reduce its energy consumption for heating, cooling, and lighting. A reference design has been studied and the effects of extending the overhang during summer and fall, varying glazing area, employing RIB, and reducing internal heat by natural lighting have been considered. The use of RIB and the extendable overhang increases the optimum window glazing area and the solar heating fraction. A mass-storage wall which will likely be included in the final design has also been considered. A figure of merit for commercial buildings is the total annual energy consumption per unit area of floor space. A highly efficient office building in the Oak Ridge area typically uses 120 to 160 kW hr/m sq. The Joint Institute reference design with natural lighting, an annual average heat pump coefficient of performance (COP) equal to 1.8, RIB, and the extendable overhang uses 71 kWhr/m sq. This figure was determined from NBSLD simulation corrected for the saving from

N80-29888# Brookhaven National Lab., Upton, N. Y. National Center for Analysis of Energy Systems.

## ELECTRIC UTILITIES AND RESIDENTIAL SOLAR SYSTEMS

Robert Bright and Harry Davitian Apr. 1980 17 p ref Proposed for presentation at the 1980 Ann. Meeting of the Am. Sect., Intern. Solar Energy Soc. Conf., 2 Jun. 1980 Submitted for publication

NTIS

(Contracts EY-76-C-02-0016)

(BNL-27711; CONF-800604-21) Avail:

HC A02/MF A01

The long-run incremental cost (LRIC) of providing electricity for solar heating and hot water systems is estimated for three utilities using a utility capacity expansion model and compared to the cost of providing electricity to electric-only systems. It is found that the LRIC for solar backup is no more than the LRIC of electricity used for purely electric heating and hot water devices and also no more than the incremental cost of normal load growth. For the three utilities, there appears to be little basis for rate distinctions between solar devices using electric backup and electric only heating and hot water devices. Off-peak storage heating and hot water devices have a much lower LRIC than the standard systems. Compared to average cost pricing, incremental cost pricing offers considerable benefits to customers using solar and electric heat and hot water, especially if a separate lower rate is adopted for off-peak storage devices. Substantial savings in the use of oil and gas fuels can be achieved if residences using these fuels convert to solar systems, savings not necessarily achievable by a shift, instead, to electric systems.

N80-29889# Sandia Labs., Albuquerque, N. Mex. SURVEY OF SELECTIVE SOLAR ABSORBERS AND THEIR LIMITATIONS

D. M. Mattox 1980 25 p refs Presented at the Intern. Conf. on Mater. for Photothermal Energy Conversion, Corsica. France, 6 May 1980 (Contracts EY-76-C-04-0789) DE-AC04-76DP-00789)

(SAND-79-2371C; CONF-800530-1) NTIS

HC A02/MF A01

A number of selective absorber coating systems with high solar absorptance exist which may be used in the mid-temperature range. Some of the systems are more chemically and thermally stable than others. Unfortunately, there are large gaps in the stability data for a large number of the systems. In an inert environment, the principal degradation mechanisms are interdiffusion between the layers or phases and changes in surface morphology. These degradation mechanisms would be minimized by using refractory metals and compounds for the absorbing layer and using refractory materials or diffusion barriers for the underlayer. For use in a reactive environment, the choice of materials is much more restrictive since internal chemical reactionscan change phase compositions and interfacial reactions can lead to loss of adhesion. For a coating process to be useful, it is necessary to determine what parameters influence the performance of the coating and the limits to these parameters. This process sensitivity has a direct influence on the production process controls necessary to produce a good product. Experience with electroplated black chrome has been rather disappointing. Electroplating should be a low cost deposition process but the extensive bath analysis and optical monitoring necessary to produce a thermally stable produce for use to 320 C has increased cost signficantly.

N80-29892# Midwest Research Inst., Golden, Colo. Energy Research Inst.

NATIONAL SOLAR OPTICAL MATERIALS PROGRAM PLAN: AN OVERVIEW

Keith D. Masterson Mar. 1980 6 p refs Presented at Los Angeles Tech. Symp., North Hollywood, Calif., 4-7 Feb. 1980; sponsored by Soc. of Photo-Opt. Instrumentation Engr. (Contract EG-77-C-01-4042)

HC\_A02/MF\_A01

CONF-800207-3) (SERI/TP-641-619;

Avail: NTIS

A coordinated national program is being formulated to adapt and develop optical materials to support a goal of meeting 20% of our national energy needs with solar by the year 2000. The program contains elements covering absorber, reflector, and transmitter materials but no photovoltaic materials. These elements include research on glass and polymer materials for glazing and reflector components, environmental testing, and long-term reliability modeling. Program subelements that support R and D and encourage commercialization of new products are also discussed. An overview of the proposed funding levels is presented. DOE

N80-29893# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

BIOLOGICAL SOLAR CELL

Michael Seibert and A. Frederick Janzen (Photochemical Research Associates, Inc., London, Ontario) Apr. 1980 8 p refs Presented at the Am. Sect. of the Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2-6 Jun. 1980

(Contract EG-77-C-01-4042)

CONF-800604-16) (SERI/TP-623-856; \*\* NTIS Avail:

HC A02/MF A01

Recent reports have demonstrated the possibility of employing photoactive, biological membrane components in photoelectrochemical cells. Present studies have led to the attachment of a much simpler biological complex, the bacterial photosynthetic reaction center isolated from Rhodopseudomonas sphaeroides, directly onto a SnO2 semiconductor electrode. Light induced photovoltages and photocurrents not attributable to Dember effects were observed in photoelectrochemical cells employing reaction center coated, SnO2 working electrodes. Such reaction center electrodes may serve as model systems for future organic photovoltaic devices.

N80-29894# Midwest Research Inst., Golden, Colo. - Solar Energy Research Inst. SUMMARY OF SOLAR EXPERIENCE WITH THE SOILING

OF OPTICAL SURFACES

Patrick J. Call Feb. 1980 15 p refs Workshop held in Denver, 16-17 Jul. 1979 (Contract EG-77-C-01-4042)

(SERI/TP-334-478) Avail: NTIS HC A02/MF A01

The results of a workshop held on July 16-17, 1979 to discuss available experimental data, current and planned experimental investigations, directly applicable optical principles, and relevant theory are summarized. The summary is in terms of the magnitude of effects on various types of systems and the effects of location, surface properties, and natural/artificial removal. The economics of prevention, tolerance, and removal are also summarized.

N80-29895# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

OVERVIEW OF THICK-FILM TECHNOLOGY AS APPLIED TO SOLAR CELLS

K. Firor and S. Hogan Jan. 1980 8 p refs Presented at the Electron. Component Conf. of the IEEE, 28-30 Apr. 1980 (Contract EG-77-C-01-4042)

(SERI/.TP-331-541; CONF-800421-3)

HC A02/MF A01

The use of thick film technology in solar cell development is discussed in some detail. Screen printing as an alternate to more expensive, high vacuum techniques in several of the production steps during the manufacture of silicon solar cells is discussed. Screen printing is fairly well established as a means of providing electrical contact to a cell and for the formation of a back surface field. Under investigation are the possibilities of non-noble metal contacts and protective and antireflective coatings applied to solar cells by the use of screen printing. The fabrication of the active layers of a solar cell, using thick film inks made up of 2 to 6 semiconductors is also addressed.

N80-29897\*# PRC Energy Analysis Co., McLean, Va. SOME QUESTIONS AND ANSWERS ABOUT THE SATEL-LITE POWER SYSTEM (SPS)

Jan. 1980 46 p refs Sponsored by NASA (Contract DE-AC01-79ER-10041)

(NASA-CR-163329; NTIS DOE/ER-0049/1)

HC A03/MF A01 CSCL 10A

Progress in the evaluation of the concept of obtaining significant amount of electrical energy from space through the Satellite Power System is reported. The Concept Development and Evaluation Program plan is described including: systems definition, environmental assessment, societal assessment, and comparative assessment.

N80-29899# Ueland and Junker, Architects and Planners, Philadelphia, Pa.

SOLAR ATRIUM: A HYBRID SOLAR HEATING AND COOLING SYSTEM Technical Progress Report, 19 Sep. -19 Dec. 1979

Mark Ueland 28 Dec. 1979 11 p refs

(Grant EG-77-G-04-4135)

(ALO-4135-T2; TPR-9) Avail: NTIS HC A02/MF A01

A program of applied research was developed for the design, construction, and monitoring of an inovative concept of solar heating and cooling called solar atrium. The solar atrium concept is adaptable to residences and smaller commercial and institutional buildings. It is designed to be constructed of materials and equipment that are economical and readily available. Cost effectiveness of installation and operation is a primary design objective. Progress in construction and instrumentation is listed. DOE

N80-29900\*# Department of Energy, Washington, D. C. Office of Energy Research. 11 SATELLITE POWER SYSTEM (SPS) FY 79 PROGRAM

SUMMARY

Jan. 1980 200 p refs

(NASA-CR-163479; DOE/ER-0037) NTIS HC A09/MF A01 CSCL 10A

The Satellite Power System (SPS) program a joint effort to develop an initial understanding of the technical feasibility, the economic practicality, and the social and environmental acceptability of the SPS concept is discussed. This is being accomplished through implementation of the Concept Development and Evaluation Program Plan which is scheduled for completion by the end of FY 1980. This Program Summary not only covers FY 1979 but includes work completed in FY 1977 and FY 1978 in order to give a comprehensive picture of the DOE involvement in the SPS concept development and evaluation process. DOE

N80-29903# California Univ., Berkeley. Lawrence Berkeley Energy and Environment Div.

HUMAN COMFORT AND AUXILIARY CONTROL CONSI-DERATIONS IN PASSIVE SOLAR STRUCTURES

Wayne Place, Ronald Kammerud, Brandt Andersson, Benay Curtis, William Carroll, Craig Christensen, and Mark Hannifan Apr. 1980 9 p refs Presented at the Intern. Congr. on Building Energy Management, Povoa de Varzim, Portugal, 12-16 May 1980 Prepared in cooperation with Midwest Research Inst., Golden,

(Contract W-7405-eng-48)

(LBL-10034:

CONF-800524-3) NTIS Avail: HC A02/MF A01

Energy consumption and human comfort implications of various passive solar and energy conservation strategies are investigated for single family, one story, slab on grade residences in Albuquerque, NM and Washington, DC. The building energy analysis computer program BLAST is used to perform annual dynamic heating and cooling load calculations for a building in which the glazing area, glazing location, and thermal mass are varied systematically. The impacts on building performance of forced flow ventilative cooling and nighttime and weekday thermostat setpoint adjustments are investigated. The results indicate that the annual heating and cooling loads are highly sensitive to glazing area, glazing location, and thermostatic controls. Annual cooling loads are substantially reduced by increased thermal mass in the walls. In contrast, annual heating loads are fairly insensitive to increased thermal mass in the walls, unless very large areas of south glazing are involved. DOE

N80-29904# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

OVERVIEW-ABSORPTION/RANKINE SOLAR COOLING **PROGRAM** 

Michael Wahlig, Al Heitz, and Barbara Boyce Mar. 1980 5 p. Presented at the Ann. DOE Active Solar Heating and Cooling Contractors' Rev. Meeting, Incline Village, Nev., 26-28 Mar. 1980

(Contract W-7405-eng-48)

(LBL-10770: CONF-800340-7) HC A02/MF A01

NTIS Avail:

The tasks being performed in the absorption and Rankine program areas run the gamut from basic work on fluids to development of chillers and chiller components, to field and reliability testing of complete cooling systems. In the absorption program, there are six current and five essentially completed projects. In the Rankine program, there are five current projects directly supported by DOE, and three projects funded through and managed by NASA/MSFC (Manned Space Flight Center, Huntsville, Alabama). The basic features of these projects are discussed. The systems under development in five of these current projects were selected for field testing in the SOLERAS program, a joint US-Saudi Arabian enterprise. Some technical highlights of the program are presented.

N80-29906# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

DEVELOPMENT OF HIGH TEMPERATURE RESISTANT, SOLAR ABSORBER SURFACES Final Report

Werner Scherber and Guenther Dietrich Bonn Bundesministerium fuer Forschung und Technologie Dec. 1979 113 p refs In GERMAN: ENGLISH summary Sponsored by Bundesministerium

fuer Forschung und Technologie ISSN-0340-7608) (BMFT-FB-T-79-70: HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 23.55

Preparation techniques for selective coatings on high temperature solar collectors and their economic use were investigated by reproducing and improving known methods as well as developing alternative types of selective coatings. All samples were evaluated applying uniform criteria. The transfer of laboratory results to large area deposition is demonstrated to be feasible for a coating suitable for absorber temperatures up to 400 C. In-service results for prototypes of selective coated central receiver tubes produced and installed in a 10 kW solar power station in Cairo, Egypt are discussed. Author (ESA)

N80-29907# Battelle Inst., Frankfurt am Main (West Germany). DEVELOPMENT OF A CADMIUM SELENIDE THIN FILM SOLAR CELL Final Report

Dieter Bonnet Bonn Bundesministerium fuer Forschung und Technologie Dec. 1979 87 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-T-79-72; ISSN-0340-7608) NTIS Avail: HC A05/MF A01: Fachinformationszentrum, Karlsruhe, West Germany DM 18,50

A project aimed at developing a CdSe MIS thin film solar cell was conducted. Fourteen materials were studied with regard to their suitability as I-layers. Two of these compounds, i.e., ZnSe and SbSe, were found to result in cells with relatively high photovoltage and high photocurrent. The preparation procedure for 2 micron thick active CdSe film was optimized with respect to all essential parameters. Commercial, nominally very pure CdSe material from six manufacturers was found either to be unsuited or to lead to properties greatly varying from batch to batch. The best reproducible results were obtained with a material directly synthesized from elements which are commercially available in highly pure form. Tests show that experimental cells achieve efficiencies of 4.5%. Short circuit densities of more than 25 mA/cu cm, given incident solar radiation of 100 mW/cu cm, and open circuit voltages around 600 mV are realized. Further enhancement of the photovoltage up to 700 or 800 mV seems possibly by suitable doping of the CdSe layer and compensation of the doping near the surface. This as well as an enhancement of the fill factor from 55% to 70% could increase the cell efficiency to 9 or 10%. Author (ESA)

N80-30348# Societe Europeenne de Propulsion, Vernon (France). Dept. Espace.

STUDY ON THE UTILIZATION OF SOLAR ENERGY FOR THE OPERATION OF SPACELAB MATERIAL SCIENCE **FURNACES Final Report** 

M. Robert, ed. and C. Fouche, ed. 1979 110 p refs (Contract ESA-3787/78 F-FC(SC))

(ESA-CR(P)-1301) Avail: NTIS HC A06/MF A01

User requirements, Spacelab constraints, options for furnace type, sample storage and retrieval, and optics associated with the development of a solar energy system for a materials science furnace are studied. A design is proposed, including mass and dimensions, for an isothermal furnace for metallurgy experiments (temperatures up to 1800 deg). The mirror allows the concentration of 2 kW at the furnace aperture. The system is to be installed. on a free flying pallet. Author (ESA)

N80-30349# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

STUDY ON THE UTILIZATION OF SOLAR ENERGY FOR THE OPERATION OF SPACELAB MATERIAL SCIENCE FURNACES Final Report

M. Bader, J. P. Baselt, W. Breitling, H. Lenski, and K. Suttner 24 Oct. 1979 113 p refs (Contract ESA-3788/78-F-FC(SC))

(DS-ERT-21-79; ESA-CR(P)-1314)

NTIS Avail.

HC A06/MF A01 The user requirements, possibilities and constraints resulting from the Orbiter/Spacelab vehicle are summarized. The major elements of a solar heating facility are defined and technical solutions for the various components are outlined. Two different concepts are possible: a light concept and heat concept. The heat concept uses a heat storage element and heat pipe furnaces for isothermal, gradient or zone melting processing. It operates in day/night orbits up to temperature of 1250 - 1580 K, depending on the process. In the light concept light transfer in a light guide is discussed, but a more simple system with the furnace directly in the focus is described in detail. This furnace allows zone melting up to 3000 K and an isothermal coversion up to 200 K. For both concepts the technology is available and the usage of solar heating facilities appears very attractive.

Author (ESA)

N80-30530# Midwest Research Inst., Golden, Colo. PROPERTIES OF A SOLAR ALUMINA-BOROSILICATE

R. T. Coyle, M. A. Lind, J. E. Shelby, J. Vitko, and A. F. Shoemaker Jan. 1980 15 p refs Presented at the 12th Intern. Glass Congr., Albuquerque, N. Mex., 6 - 11 Jul. 1980 (Contract EG-77-C-01-4042)

(SERI/TP-334-565; CONF-800705-1)

HC A02/MF A01

Solar energy applications place unique requirements on sheet glass including very low solar absorption, outstanding stability of absorption in the outdoor environment, low cost, and elastic formability for making concentrating mirrors. A solar sheet glass was developed. In evaluations reported the glass shows outstanding chemical durability and optical and mechanical properties.

N80-30893\*# IBM Federal Systems Div., Huntsville, Ala. Federal

SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION REPORT FOR IBM SYSTEM 4 AT CLINTON, MISSISSIPPI Seasonal Report, Oct. 1978 - Mar. 1980

Jul. 1980 91 p refs Prepared for DOE (Contract NAS8-32036)

(NASA-CR-161509) Avail: NTIS HC A05/MF A01 **CSCL** 10A

The IBM System 4 Solar Energy System is described and evaluated. The system was designed to provide 35 percent of the space heating and 63 percent of the domestic hot water preheating for a single family residence located within the United States. The system consists of 259 square feet of flat plate air collectors, a rock thermal storage containing 5 1/2 ton of rock, heat exchangers; blowers, a 52 gallon preheat tank, controls, and associated plumbing. In general, the performance of the system did not meet design expectations, since the overall design solar fraction was 48 percent and the measured value was 32 percent. Although the measured space heating solar fraction at 32 percent did agree favorably with the design space heating solar fraction at 35 percent, the hot water measured solar fraction at 33 percent did not agree favorably with the design hot water solar fraction of 63 percent. In particular collector array air leakage, dust covered collectors, abnormal hot water demand, and the preheat tank by pass valve problem are main reasons for the lower performance.

N80-30894\* # IBM Federal Systems Div., Huntsville, Ala. Federal Systems Div.

SOLAR ENERGY SYSTEM ECONOMIC EVALUATION FINAL REPORT FOR SEMCO-LOXAHATCHEE, LOXAHATCHEE NATIONAL WILDLIFE REFUGE, PALM BEACH COUNTY, FLORIDA Final Report

Jul. 1980 98 p refs Prepared for DOE

(Contract NAS8-32036)

(NASA-CR-161512) Avail: NTIS HC A05/MF A01 **CSCL** 10A

Economic analysis of the solar energy system installed at Loxahatchee, was developed for Loxahatchee and four other sites typical of a wide range of environmental and economic conditions in the continental United States. This analysis was accomplished based on the technical and economic models in the f Chart design procedure with inputs based on the characteristics of

the installed system and local conditions. The results are expressed in terms of the economic parameters of present worth of system costs over a projected twenty year life, life cycle savings, year of positive savings and year of payback for the optimized solar energy system at each of the analysis sites. The sensitivity of the economic evaluation to uncertainties in constituent system and economic variables was also investigated. The results demonstrate that the solar energy system is economically viable at all of the five sites for which the analysis was conducted.

N80-30895\*# City of Kansas City, Mo.
SOLAR HEATING AND DOMESTIC HOT WATER SYSTEM INSTALLED AT KANSAS CITY, FIRE STATIONS, KANSAS CITY, MISSOURI Final Report
Jul. 1980 170 p Sponsored by NASA
(Contract EX-76-C-01-2373)

(NASA-CR-161513) Avail: NTIS HC A12/MF A01 CSCL

The solar system was designed to provide 47 percent of the space heating, 8,800 square feet area and 75 percent of the domestic hot water (DHW) load. The solar system consists of 2,808 square feet of Solaron, model 2001, air, flat plate collector subsystem, a concrete box storage subsystem which contains 1,428 cubic feet of 0.5 inch diameter pebbles weighing 71.5 tons, a DHW preheat tank, blowers, pumps, heat exchangers, air ducting, controls and associated plumbing. Two 120 gallon electric DHW heaters supply domestic hot water which is preheated by the solar system. Auxiliary space heating is provided by three electric heat pumps with electric resistance heaters and four 30 kilowatt electric unit heaters. There are six modes of system operation.

N80-30896\* # IBM Federal Systems Div., Huntsville, Ala. Federal Systems Div.

SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION REPORT FOR IBM SYSTEM 3, GLENDO, WYOMING Seasonal Report, Jan. - Dec. 1979

Jun. 1980 85 p refs Prepared for DOE

(Contract NAS8-32036)

(NASA-CR-161520) Avail: NTIS HC A05/MF A01

The analysis used was based on instrumented system data monitored and collected for at least one full season of operation. The long-term field performance of the installed system is described. Technical contributions to the definition of techniques and requirements for solar energy system design are given. T.M.

N80-30898\*# ECON, Inc., Princeton, N. J. SPS SALVAGE AND DISPOSAL ALTERNATIVES Report

30 Jun. 1980 90 p refs (Contract NAS8-33783)

(NASA-CR-161548;

Rept-80-1489) HC A05/MF A01 CSCL 10A

Avail: NTIS

A wide range of salvage options exist for the satellite power system (SPS) satellite, ranging from use in and beyond geosynchronous orbit to use in low Earth orbit to return and use on Earth. The satellite might be used intact to provide for various purposes, it might be cannibalized, or it might be melted down to supply materials for space- or ground-based products. The use of SPS beyond its nominal lifetime provides value that can be deducted from the SPS capital investment cost. It is shown that the present value of the salvage value of the SPS satellites, referenced to the system initial operation data, is likely to be on the order of five to ten percent of its on-orbit capital cost. (Given a 30 year satellite lifetime and a four percent discount rate, the theoretical maximum salvage value is 30.8 percent of the initial capital cost). The SPS demonstration satellite is available some 30 years earlier than the first full-scale SPS satellite and has a likely salvage value on the order of 80 percent of its on site capital cost. In the event that it becomes desirable to dispose of either the demonstration or full-scale SPS satellite, a number of disposal options appear to exist for which intact disposal costs are less than one percent of capital costs.

N80-30911# Sandia Labs., Albuquerque, N. Mex. UTILITY VIEWS ON SOLAR THERMAL CENTRAL RECEIV-

M. J. Fish Apr. 1980 67 p refs (Contract EY-76-C-04-0789)

(SAND-80-8203) Avail: NTIS HC A04/MF A01

The concerns of a number of US utilities about the solar thermal central receiver concepts are reported. The discussions forced on identifying technical demonstrations and government incentives necessary for commercializing the technology. The implications for a commercialization plan are discussed.

N80-30912# Rockwell International Corp., Anaheim, Calif. Electronic Devices Div.

THIN FILMS OF INP FOR PHOTOVOLTAIC ENERGY CONVERSION Quarterly Technical Progress Report, 29 Sep. - 28 Dec. 1979

Harold M. Manasevit, R. P. Ruth, L. A. Moudy, J. J. J. Yang, and R. E. Johnson Jan. 1980 45 p refs

(Contract DE-AC02-79ET-23004)

(COO-3004-2; QTPR-2) Avail: NTIS HC A03/MF A01

Growth parameters are established using triethylindium, diethylzinc (DEZn), and PH3 sources for the formation of Zn doped p type inP films. The properties of grains and grain boundaries in polycrystalline InP films are investigated using several polycrystalline film/substrate combinations, including tungsten (W) layers produced by roller coating and screen printing on polycrystalline alumina, and mechanically abraded surfaces of single crystal bulk InP.Fe wafers. The use of GaP as an alternative intermediate layer material to GaAs on low cost substrates for subsequent growth of InP films is also examined. Auger electron spectroscopy analysis done on a group of specially prepared Zn treated films of polycrystalline InP indicates the presence of Zn at surfaces of InP:Zn films grown on Al and/or heat treated in high concentrations of DEZn at 600 C. However, no Zn is detected in polycrystalline films grown under deposition conditions that would be expected to produce highly doped p type epitaxial films if single crystal substrates were used. DOE

#### N80-30913# Los Alamos Scientific Lab., N. Mex. PERFORMANCE ESTIMATES FOR ATTACHED SUNSPACE PASSIVE SOLAR HEATED BUILDINGS

Robert D. McFarland and Robert W. Jones (South Dakota Univ., Vermillion) 1980 6 p refs Presented at 1980 Ann. Meeting of Am. Sect. of Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2-6 Jun. 1980

(Contract W-7405-eng-36)

CONF-800604-4) (LA-UR-80-853; Avail:

HC A02/MF A01

Performance predictions are made for attached Sun space types of passively solar heated buildings. The predictions are based on hour by hour computer models developed in the framework of PASOLE, the passive solar energy simulation program. The models have been validated by detailed comparison with actual hourly temperature measurements taken in attached sunspace test rooms.

N80-30919# Brookhaven National Lab., Upton, N. Y. of Energy and Environment.

HYBRID PHOTOVOLTAIC/THERMAL SYSTEMS WITH A

SOLAR-ASSISTED HEAT PUMP
Edward A. Kush 1980 7 p refs Presented at the Am.
Sect./Intern. Solar Energy Soc. 1980 Ann. Meeting Phoenix. Ariz., 2-6 Jun. 1980

(Contracts EY-76-C-02-0016; DE-AC02-76CH-00016)

(BNL-27667) Avail: NTIS HC A02/MF A01

An outline of possibilities for effective use of photovoltaic/ thermal (PV/T) collectors with a Solar Assisted Heat Pump is given. A quantitative analysis of the performance and cost of the various configurations as a function of regional climates, using up-to-date results from solar heat pump and PV/T collector studies, will be required for more definitive assessment; and it is recommended that these be undertaken in the PV/T Program. Particular attention should be paid to development of high performance PV/T collectors, matching of heat pump electrical system to PV array and power conditioning characteristics, and optimization of storage options for cost effectiveness and utility

N80-30920# Battelle Pacific Northwest Labs., Richland, Wash, SUPPLEMENTARY MATERIAL ON PASSIVE SOLAR HEATING CONCEPTS: A COMPILATION OF PUBLISHED ARTICLES. PRESENTED IN CONJUNCTION WITH A SERIES OF PASSIVE SOLAR HEATING SEMINARS SPONSORED BY THE SOLAR ENERGY TECHNOLOGY TRANSFER PROGRAM

May 1979 99 p

(Contract EY-76-C-06-1830)

(PNL-SA-7820) Avail: NTIS HC A05/MF A01

A compilation of published articles and reports dealing with passive solar energy concepts for heating and cooling buildings is presented. The following are included: fundamentals of passive systems, applications and technical analysis, graphic tools, and information sources.

N80-30921# Pennsylvania State Univ., University Park. Materials Research Lab.

CONTROLLED CADMIUM TELLURIDE THIN FILMS FOR SOLAR CELL APPLICATIONS (EMERGING MATERIALS SYSTEMS FOR SOLAR CELL APPLICATIONS) Quarterly Progress Report, 9 Oct. 1979 - 8 Jan. 1980

K. Vedam, M. B. Das, and S. V. Krishnaswamy Feb. 1980 28 p refs

(Contract DE-AC04-79ET-23013)

(DOE/ET-23023/T3; QPR-3) Avail: NTIS HC A03/MF A01 Emphasis during the third quarter of the program was on the improvement of the quality of sputtered films, their characterization and use in the fabrication of Schottky barrier type diodes and solar cell structures. Films prepared under different conditions and on different substrates were examined showing modular growths under certain conditions. I-V, C-V, and photovoltaic characteristics were measured on numerous samples based on n- and p-type films on Ni substrates having top metallization of either evaporated Au and Al. The n-type samples showed up to 200 mV V/sub oc/and small short-circuit currents. The characteristics observed are indicative of the presence of interfacial layer and surface states. Surface state's capacitance were measured on p-type samples metalized with Au.

N80-30925# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

DEVELOPMENT OF SOLAR DRIVEN ABSORPTION AIR CONDITIONERS AND HEAT PUMPS

K. Dao, M. Wahlig, E. Wali, J. Rasson, and E. Molishever Mar. 1980 3 p refs Presented at the DOE Active Solar Heating and Cooling Contractors Rev. Meeting, Lake Tahoe, Nev., 26 Mar. 1980

(Contract W-7405-eng-48)

(LBL-10771: CONF-800340-6)

NTIS Avail:

HC A02/MF A01

The development of absorption refrigeration systems for solar active heating and cooling applications is discussed. The approaches investigated are those using air-cooled condenserabsorber and those leading to coefficient of performances (COP) that increase continuously with heat source temperature. This is primarily an experimental project, with the emphasis on designing, fabricating and testing absorption chillers in operating regimes that are particularly suited for solar energy applications. It is demonstrated that the conventional single-effect ammonia-water absorption cycle can be used (with minor modifications) for solar cooling.

N80-30926# Brookhaven National Lab., Upton, N. Y. of Energy and Environment.

SOLAR ASSISTED HEAT PUMP PROGRAM OVERVIEW AND SUMMARY OF WORK AT BROOKHAVEN NATIONAL LABORATORY

John W. Andrews 1980 6 p refs Presented at the Ann. DOE Active Solar Heating and Cooling Contractors Rev. Meeting. Incline, Nev., 26-28 Mar. 1980

(Contract EY-76-C-02-0016)

(BNL-27662) Avail: NTIS HC A02/MF A01

Four generic paths for avoiding the high utility power demand for solar assisted heat pump systems when the Sun is not shining and storage is depleted are described. These include the bimodal solar assisted heat pump system, direct expansion solar collector/heat pump systems, volume dominated ground coupled systems, and area dominated ground coupled systems. Work on heat pump development, ground coupling, and low cost collectors for use with these systems is reviewed. DOE

N80-30946# Rockwell International Corp., Thousand Oaks, Calif. Electronics Research Center.

ADVANCED PHOTOVOLTAIC CONCENTRATOR CELLS Quarterly Technical Progress Report, 28 Aug. - 30 Nov.

S. W. Zehr, H. T. Yang, and J. S. Harris, Jr. Dec. 1979 43 p refs Prepared for Midwest Research Inst., Golden, Colo. (Contract EG-77-C-01-4042)

(DSE-4042-T30) Avail: NTIS HC A03/MF A01

Activities demonstrating the technical feasibility of advanced high efficiency concentrator solar converters are described. The approach is to fabricate two cell, non-lattice matched, monolithic stacked converters using optimum pairs of cells having bandgaps in the range of 1.6 to 1.7 eV and 0.95 to 1.1 eV. The low bandgap cells are to be fabricated from AlGaSb(As) compositions by LPE. These subcells are then to be joined into a monolithic structure by an appropriate thermal bonding technique which will also form the needed transparent intercell ohmic contact between the two subcells. The activities this quarter were focused on the development and study of low bandgap cell structures and attempts to develop suitable techniques for the thermal bonding operation.

N80-30947# Tata Inst. of Fundamental Research, Bombay (India). Documentation Center.

SOLAR PASSIVE SYSTEMS FOR BUILDINGS

Mar. 1980 52 p refs (NP-24377) Avail: NTIS (US Sales Only) HC A04/MF A01; DOE Depository Libraries

A survey is presented of design knowledge and systematic presentation of proven concepts is provided with suitable illustrations. Current design literature was studied to provide an overview of building practices.

#### N80-31435# Battelle Pacific Northwest Labs., Richland, Wash. WORKSHOP ON SATELLITE POWER SYSTEMS (SPS) EFFECTS ON OPTICAL AND RADIO ASTRONOMY

G. M. Stokes and Pr A. Ekstrom Apr. 1980 273 p Conf. held at Seattle, May 1979 (Contract EY-76-C-06-1830)

(CONF-7905143) Avail: NTIS HC A12/MF A01

The impacts of the satellite solar power system on astronomy are concluded to be: increased sky brightness, reducing the effective aperture of terrestrial telescopes; microwave leakage radiation causing erroneous radioastronomical signals; direct overload of radioastronomical receivers at centimeter wavelengths: and unintentional radio emissions associated with massive amounts of microwave power or with the presence of large, warm structures in orbit causing the satellites to appear as individual stationary radio sources; finally, the fixed location of the geostationary satellite orbits would result in fixed regions of the sky being unusable for observations. DOE

N80-31466\*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

ELECTRIC PROPULSION FOR SPS

Earle M. Crum In NASA. Lewis Research Center Large Space Systems/Low-Thrust Propulsion Technol. Jul. 1980 p 229-236

Avail: NTIS HC A15/MF A01 CSCL 21C

The design, and characteristics of the solar power satellite electric propulsion system are described. Both the payload powered orbital transfer vehicle and the independent powered transfer vehicle configuations are discussed. Mass estimates for the system, the average cost per system unit, and the cost per flight estimates are also given.

N80-31538# California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Molecular Research Div.

#### METALLURGICAL ANALYSIS AND HIGH TEMPERATURE DEGRADATION OF THE BLACK CHROME SELECTIVE ARSORRER

Carl M. Lampert Mar. 1980 19 p refs Presented at the Intern. Conf. on Met. Coatings, San Diego, Calif., 21-25 Apr., 1980 Submitted for publication

(Contract W-7405-eng-48) (LBL-10293; CONF-800439-6)

NTIS Avail:

HC A02/MF A01

A well known coating, Harshaw Chemical Company's Chromonyx was selected for detailed scrutiny of its properties and degradation modes when exposed to high temperatures. Both asplated and annealed microstructural models were presented. Technical means used in this microstructural characterization were: scanning and transmission electron microscopy, Auger depth profiling hemispherical reflectance and energy dispersive X-ray analysis. From these results a physical metallurgical model for wavelength selective properties of the coating was developed. Thus, it was observed that black chrome degraded as Cr2O3 oxide particles grew and chromium depleted. This effect was pronounced in air and to a lesser degree in medium vacuum. Oxidation by preferential diffusion and outgassing which causes structural changes, may take place.

N80-31652# California Univ., Livermore. Lawrence Livermore

#### GASIFICATION OF COAL WITH SOLAR ENERGY

William R. Aiman and David W. Gregg Jun. 1980 28 p refs Presented at 88th Natl. Meeting of the AIChE Conf., Philadelphia, 8-12-Jun. 1980

(Contract W-7405-eng-48)

(UCRL-84458; CONF-800610-8)

 NTIS Avail:

HC A03/MF A01

Coal reactors are adaptable to solar-energy facilities. Two advantages make solar coal gasification attractive economically: synthesis gas (a nitrogen-free product) can be produced without pure oxygen and only half as much coal is required. Solar energy is available 8 hours per day; therefore, post-gasification processing units must be oversized and equipped for rapid startup and shutdown. This disadvantage is balanced by the 50 percent reduction cost for coal and coal pretreatment equipment and in the sulfur content of the product gas. A moving bed reactor, a fluidized bed reactor, a closed-loop, heat-transfer-fluid reactor, and an open-loop, heat-transfer-fluid reactor are discussed. The expected performance of a moving-bed gasifier yields products with an energy content 25 percent higher than the initial coal compared to 17 percent higher for a fixed-bed gasifier.

#### N80-31868 California Univ., Davis. SOLAR DOMESTIC HOT WATER SYSTEM, A COMPARA-TIVE STUDY AND STORAGE TANK INVESTIGATION Ph.D. Thesis

Marvin Francis Young 1980 291 p

Avail: Univ. Microfilms Order No. 8019006

A computer program was developed to simulate five typical solar domestic hot water systems which included both thermosyphon and pumped designs that were assembled and tested. Numerical simulations of these systems were verified by comparison to experimental results. Predicted thermal performance, i.e., collector inlet and outlet temperatures, and auxiliary energy requirements were found to be in excellent agreement with experiments. The computer program was then used to predict the long term annual performance of the various systems at 14 different locations throughout California. Load size and load distribution were also varied. Economic analyses were performed on each system with the goal of identifying the most economical system at each location under a prescribed load (gallons/day) size and distribution pattern (time of day for hot water use). It was found that in almost all cases the two tank thermosyphon system was the most cost effective system for all locations, load sizes and distributions and shows promise of being the most widely used solar domestic hot water system.

Dissert. Abstr.

N80-31872\*# IBM Federal Systems Div., Huntsville, Ala. SOLAR ENERGY SYSTEM ECONOMIC EVALUATION FOR ELCAM-TEMPE, TEMPE, ARIZONA AND ELCAM-SAN DIEGO, SAN DIEGO, CALIFORNIA Final Report

Jun. 1980 102 p refs Prepared for DOE (Contract NAS8-32036)

(NASA-CR-161492) Avail: NTIS HC A06/MF A01 10A

The long term economic performance of the solar energy system at its installation site is analyzed and four additional locations selected to demonstrate the viability of the design over a broad range of environmental and economic conditions. The economic analysis of the solar energy systems that were installed at Tempe, Arizona and San Diego, California, is developed for these and four other sites typical of a wide range of environmental and economic conditions in the continental United States. This analysis is accomplished based on the technical and economic models in the f Chart design procedure with inputs based on the characteristics of the installed system and local conditions. The results are expressed in terms of the economic parameters of present worth of system cost over a projected twenty year life: life cycle savings; year of positive savings; and year of payback for the optimized solar energy system at each of the analysis sites. The sensitivity of the economic evaluation to uncertainties in constituent system and economic variables is also investigated. The results demonstrate that the solar energy system is economically viable at all of the sites for which the analysis was conducted. R.K.G.

N80-31875\*# Sanders Associates, Inc., Nashua, N. H. Energy Systems Center.

SMALL SOLAR ELECTRIC SYSTEM COMPONENTS DEMON-STRATION Final Report

Aug. 1980 123 p Original contains color illustrations (Contract JPL-955279)

(NASA-CR-163513) Avail: NTIS HC A06/MF A01 CSCL

The design and testing of high temperature thermal storage modules (TSM) are reported. The test goals were to demonstrate the thermocline propagation in the TSM, to measure the steepness of the thermocline, and to measure the effectiveness of the TSM when used in a Brayton system. In addition, a high temperature valve suitable for switching the TSM at temperatures to 1700 F is described and tested. Test results confirm the existence of a sharp thermocline under design conditions. The thermal profile was steeper than expected and was insensitive to air density over the range of the test conditions. Experiments were performed which simulated the airflow of a small Brayton engine, 20 KWe, having a pair of thermal storage modules acting as efficient recuperators. Low pressure losses, averaging 12 inches of water, and high effectiveness, 93% for a 15 minute switching cycle, were measured. The insulation surrounding the ceramic core limited thermal losses to approximately 1 KWt. The hot valve was operated over 100 cycles and performed well at temperatures up to 1700 F. M.G.

N80-31876\*# Solarex Corp., Rockville, Md.
PILOT LINE REPORT: DEVELOPMENT OF A HIGH EFFICIENCY THIN SILICON SOLAR CELL

G. Storti, J. Culik, and C. Wrigley Jul. 1980 55 p Prepared for JPL

(Contract JPL-954883)

(NASA-CR-163522: SX/115/PL-2) Avail: HC A04/MF A01 CSCL 10A

Alternate processing technologies were developed and introduced into the pilot line with a resulting increase in the efficiency of the thin cells. The introduction of an aluminum paste alloy technique for the formation of a back surface field represents a significant advance over previous techniques. The fabrication and results for quantities in excess of 2000 2 cm x 2 cm thin cells and 1000 5 cm x 5 cm thin cells are described. Substantial improvement in performance and yield of the thin cells were obtained. The overall yield of the 2 cm x 2 cm pilot line was better than 38%, while the best lot yield was greater than 51%. The average power density of the 2 cm x 2 cm cells was approximately 16.8 mW/sq cm with an average AMO (at

25 C) efficiency of 12.4%. The lot yield of the 5 cm x 5 cm pilot line improved from only 7% at the beginning of the operation to better than 17% as experience was gained. The average 5 cm x 5 cm thin cell had an AMO efficiency (at 25 C) of 11.5%.

A.R.H

N80-31877\*# Motorola, Inc., Chicago, III. PHOTOVOLTAIC MODULE ELECTRICAL TERMINATION DESIGN REQUIREMENT STUDY Final Report

F. J. Mosna, Jr. and J. Donlinger Jul. 1980 150 p Prepared for JPL

(Contract JPL-955367; JPL Proj. 2369)

(JPL-955367-80/1: NASA-CR-163518)

HC A07/MF A01 CSCL 10A

NTIS Avail:

Pertinent electrical termination attributes were identified and used in the development of selection criteria which included

function, environmental durability, utility, manufacturing, code, and cost. Significant aspects of each criteria are discussed, and eight different types of terminations are ranked according to their performance in remote, residential, intermediate, and industrial applications.

N80-31878\*# Cooperson Brack Associates, Montchanin, Del. SOLAR ENERGY SYSTEM DEMONSTRATION PROJECT AT WILMINGTON SWIM SCHOOL, NEW CASTLE, DELAWARE **Final Report** 

Jul. 1980 94 p Sponsored by NASA

(Contract EM-78-F-01-5190)

(NASA-CR-161538) Avail: NTIS HC A05/MF A01 CSCL

A solar energy system located at the Wilmington Swim School, New Castle, Delaware is described. The system was designed for a 40 percent heating and a 30 percent hot water solar contribution serving the heat loads in the following order: space heat - new addition, domestic water - entire facility, and pool heating - entire facility. On a cost basis for 2920 hours of operation, the heat reclaimed would cost \$969.66 annually if provided by gas at 3.79 per million Btu's. At 5.5 centers per kwh, heat recovery costs of \$481.80 percent a net savings of \$487.86 annually. L.F.M.

N80-31879\*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

THREE COMPUTER CODES TO READ, PLOT AND TABU-LATE OPERATIONAL TEST-SITE RECORDED SOLAR DATA

Stephen D. Stewart, Robert S. Sampson, Jr., Richard E. Stonemetz, and Sandra L. Rouse Jul. 1980 89 p Sponsored in part by

(NASA-TM-78293) Avail: NTIS HC A05/MF A01 CSCL 10A

Computer programs used to process data that will be used in the evaluation of collector efficiency and solar system performance are described. The program, TAPFIL, reads data from an IBM 360 tape containing information (insolation, flowrates, temperatures, etc.) from 48 operational solar heating and cooling test sites. Two other programs, CHPLOT and WRTCNL, plot and tabulate the data from the direct access, unformatted TAPFIL file. The methodology of the programs, their inputs, and their outputs are described.

N80-31880\* | IBM Federal Systems Div., Huntsville, Ala. SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION. SEASONAL REPORT FOR WORMSER, COLUMBIA, SOUTH CAROLINA Contractor Report, Jun. 1979 - May 1980 Aug. 1980 110 p refs Sponsored in part by DOE

(Contract NAS8-32036)

(NASA-CR-161546) Avail: NTIS HC A06/MF A01 CSCL

The Wormser Solar Energy System's operational performance from April 1979 through March 1980 was evaluated. The space heating subsystem met 42 percent of the measured space heating load and the hot water subsystem met 23 percent of the measured hot water demand. Net electrical energy savings were 4.36 million Btu's or 1277 kwh. Fossil energy savings will increase

considerably if the uncontrolled solar energy input to the building is considered.

N80-31883\*# IBM Federal Systems Div., Huntsville, Ala. SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION: SEASONAL REPORT FOR COLT YOSEMITE, YOSEMITE NATIONAL PARK, CALIFORNIA Progress Report, May 1979 - Apr. 1980

Aug. 1980 88 p refs Prepared for DOE (Contract NAS8-32036)

(NASA-CR-161539) Avail: NTIS HC A05/MF A01 CSCL

The system's operational performance from May 1979 through April 1980 is described. Solar energy satisfied 23 percent of the total performance load, which was significantly below the design value of 56 percent. A fossil savings of 80.89 million Btu's or 578 gallons of fuel oil is estimated. If uncontrolled losses could have been reduced to an inconsequential level, the system's efficiency would have been improved considerably.

N80-31894# Technical Univ. of Denmark, Lyngby. SOLAR ENERGY APPLICATIONS FOR DWELLING; MODEL-LING AND SIMULATION PART Final Report Ove Joergensen 1980 109 p

(US Sales Only)

HC A06/MF A01; DOE Depository Libraries

Methods developed within the EC countries are presented and compared. The methods were used to predict the performance of three different solar heating systems: a domestic hot water system, a pure house heating system, and a combined system. Three different sets of weather data were used: Carpentras, Hamburg, and Ireland. The comparisons were undertaken on three different timebases: yearly, monthly, and hourly. A sensitivity analysis was formed on different parameters by different programs.

N80-31895# Air Force Inst. of Tech., Wright-Patterson AFB, School of Systems and Logistics.

A REVIEW OF THE METHODS FOR PASSIVE SOLAR SYSTEMS ANALYSIS M.S. Thesis

Albert P. Allan and Gary D. Transmeir Jun. 1980 140 p refs (AD-A087509; AFIT-LSSR-66-80) HC A07/MF A01 CSCL 10/1 Avail:

Due to recent needs expressed by the Air Force, a review and evaluation of the methods of analysis for passive solar energy systems was conducted. The methods of analysis evaluated were those that could be worked without the use of computers or programmable calculators. A selection model was designed to systematically and objectively evaluate the methods. The selection model was a variation of a scoring model and based on six criteria. The criteria were: performance, economics, flexibility, implementation, usability, and computing devices. Of the methods evaluated, the Passive Solar Design Handbook was the recommended method of analysis to be used in the Air Force. The method was written by the Los Alamos Scientific Laboratory for the Department of Energy. This method was comprehensive yet simple to use and understand.

N80-31896# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. VOLUME 2. BOOK 1: CONCEPTUAL DESIGN, SECTIONS 1 THROUGH 4 Final Report

Jan. 1980 277 p

(Contract DE-AC03-78ET-20567)

(DOE/ET-20567/1-2-Bk-1; ESG-79-30-Vol-2-Bk-1) Avail: NTIS' HC A13/MF.A01

Solar/fossil steam Rankine cycle, commercial scale, power plant systems that are economically viable and technically feasible are described. The market analysis, parametric analysis, and the selection process for the preferred system are given.

Author (DOE)

N80-31897# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. VOLUME 2, BOOK 2: CONCEPTUAL DESIGN, SECTIONS 5 AND 6 **Final Report** 

Jan. 1980 317 p refs

(Contract DE-ACO3-78ET-20567)

(DOE/ET-20567/1-2-Bk-2: ESG-79-30-Vol-2-Bk-2) Avail: NTIS HC A14/MF A01

Solar/fossil steam Rankine cycle, commercial scale, power plant systems that are economically viable and technically feasible are described. The detailed conceptual design and cost/ performance estimates and an assessment of the commercial scale solar central receiver hybrid power system are given.

Author (DOE)

N80-31898# Midwest Research Inst., Golden, Colo. BASIC RESEARCH NEEDS AND PRIORITIES IN SOLAR ENERGY. VOLUME 1: EXECUTIVE SUMMARY. TECHNOL-OGY CROSSCUTS FOR DOE

T. S. Jayadev, ed. and David Roessner, ed. Jan. 1980 49 p. refs

(Contract EG-77-C-01-4042)

(SERI/TR-351-358-Vol-1) Avail: NTIS HC A03/MF A01

Priorities for basic research important to the future development of solar energy are presented. More than 120 leading scientists who were engaged in or knowledgeable of solar related research were surveyed. The scientific disciplines included in the report were chemistry, biology, materials sciences, engineering and mathematics, and the social and behavioral sciences. Each discipline was subdivided into two to five topical areas and, within each topical area, research needs were described and ranked according to the priorities suggested in the survey. Three categories of priority were established: Crucial, important, and needed. A narrative accompanying the description of research needs in each topical area discusses the importance of research in the area for solar energy development and presents the bases for the priority rankings recommended.

N80-31899# Midwest Research Inst., Golden, Colo. BASIC RESEARCH NEEDS AND PRIORITIES IN SOLAR ENERGY. VOLUME 2: TECHNOLOGY CROSSCUTS FOR

J. S. Jayadev and D. Roessner Jan. 1980 93 p refs (Contract EG-77-C-01-4042)

(SERI/TR-351-358-Vol-2) Avail: NTIS HC A05/MF A01

Priorities for basic research important to the future developments of solar energy are identified, described, and recommended. The scientific disciplines included in the report are: chemistry; biology; materials sciences; engineering and mathematics; and the social and behavioral sciences. Each discipline is subdivided into two to five topical areas and within each topical area research needs are described and ranked according to the priorties suggested in the survey. Three categories of priority were established: crucial, important, and needed. The importance of research in the area for solar energy development is discussed and the bases for the priority rankings recommended are presented.

N80-31903# Acurex Corp., Mountain View, Calif. Energy Div.

DESIGN, CONSTRUCTION, AND OPERATION OF A 150 KW SOLAR-POWERED IRRIGATION FACILITY, PHASE 2 Final Report, 30 Sep. 1977 - 30 Sep. 1979

D. Duffy, M. Matteo, and D. Rafinejad May 1980 147 p refs (Contract EG-77-C-04-4159)

(ALO-4159-1) Avail: NTIS HC A07/MF A01

A solar powered experimental facility providing 150 kW of electric power for the operation of deep well irrigation pumps was designed and constructed. The solar collectors tracked on full automatic, and the power conversion system was started and operated on automatic control.

N80-31904# Rockwell International Corp., Thousand Oaks, Calif. ADVANCED PHOTOVOLTAIC CONCENTRATOR CELLS

#### Quarterly Technical Progress Report, 1 Dec. 1979 - 29 Feb. 1980

S. W. Zehr, H. T. Yang, J. J. Yang, and J. S. Harris, Jr. 1980 31 p refs Prepared for Midwest Research Inst., Golden, Colo. (Contract DE-AC02-77CH-00178)

(DSE-4042-T40; QTPR-2) Avail: NTIS HC A03/MF A01

Activities aimed at demonstrating the technical feasibility of advanced high efficiency concentrator solar converters are described. They were largely focused on the development and study of low bandgap cell structures and attempts to develop suitable techniques for the thermal bonding operation. DOE

N80-31911# Midwest Research Inst., Golden, Colo. Industrial Applications and Policy Branch.

#### INVESTIGATION OF LEARNING AND EXPERIENCE **CURVES**

Frank Krawiec, John Thornton, and Michael Edesess Apr. 1980 193 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-353-459) Avail: NTIS HC A09/MF A01

The applicability of learning and experience curves for predicting future costs of solar technologies is assessed, and the major test case is the production economics of heliostats. Alternative methods for estimating cost reductions in systems manufacture are discussed, and procedures for using learning and experience curves to predict costs are outlined. Because adequate production data often do not exist, production histories of analogous products/processes are analyzed and learning and aggregated cost curves for these surrogates estimated. If the surrogate learning curves apply, they can be used to estimate solar technology costs. However, an approach that combines a neoclassical production function with a learning by doing hypothesis is needed to yield a cost relation compatible with the historical learning curve and the traditional cost function of economic theory.

#### N80-31913# Lincoln Lab., Mass. Inst. of Tech., Lexington. ANALYTICAL PREDICTION OF LIQUID PHOTOVOLTAIC/ THERMAL FLAT-PLATE COLLECTOR PERFORMANCE Pattabiraman Raghuraman 29 Nov. 1979 19 p refs (Contract EY-76-C-02-4094)

(COO-4094-66) Avail: NTIS HC A02/MF A01

A one dimensional analysis that predicts the electrical and thermal efficiencies of a liquid photovoltaic/thermal flat plate collector was developed. The analysis, reduces the 15 percent difference between analysis and measured thermal efficiency obtained by the classical analysis of Hottel and Whillier.

#### N80-31914# Technische Hogeschool, Delft (Netherlands). ABSORPTION REFRIGERATION MACHINE DRIVEN BY **SOLAR HEAT Final Report**

C. Keizer and S. H. Liem 1980 101 p refs (EUR-6748-EN) Avail: NTIS (US Sales Only) HC A06/MF A01; **DOE Depository Libraries** 

A mathematical model of a single and a two stage solar absorption regrigeration system is developed in which data of collectors and weather data can be implicated. The influence of the generator, the absorber efficiencies, and the cooling temperature on the coefficient of performance (COP) of a singe and two stage absorption refrigeration process are investigated. For low generator temperatures the absorber efficiency has more influence on COP than the generator efficiency. Only spectral selective double window and high performance collectors can be used for air cooled solar absorption refrigeration systems at an evaporator temperature of -5 C. It is concluded that a water cooled solar absorption refrigeration system in combination with a solar tapwater installation for household use can be achieved with 6 to 8 square meters high performance collector area. DOE

N80-31916# Midwest Research Inst., Golden, Colo. Energy Research Inst.

EFFECT OF CIRCUMSOLAR RADIATION ON PERFOR-MANCE OF FOCUSING COLLECTORS

Paul Bendt and Ari Rabl Apr. 1980 58 p refs (Contract EG-77-C-01-4042)

(SERI/TR-34-093) Avail: NTIS HC A04/MF A01

Circumsolar data are used to develop fast computational procedures for calculating the effect of circumsolar radiation on both the instantaneous and the long term average performance of focusing collectors. For predictions of long term average performance, a standard synthetic circumsolar scan has been developed that describes the brightness distribution of the solar disk (limb darkening) and of the circumsolar region. The radiation intercepted by a receiver is calculated separately for the solar portion and for the circumsolar portion of this standard Sun shape, and these two contributions are then weighted according to the long term average circumsolar ratio for the location and period under study.

N80-31917# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

#### OPTICAL ANALYSIS OF POINT FOCUS PARABOLIC RADIATION CONCENTRATORS

Paul Bendt and Ari Rabl Apr. 1980 39 p refs (Contract EG-77-C-01-4042)

(SERI/TR-631-336) Avail: NTIS HC A03/MF A01

A simple formalism is developed for analyzing the optical performance of point focus parabolic radiation concentrators. To account for off axis aberrations of the parabola, an angular acceptance function is defined as that fraction of a beam of parallel radiation incident on the aperture which would reach the receiver if the optics were perfect. The radiation intercepted by the receiver of a real concentrator is obtained as a convolution of angular acceptance function, of optical error distribution, and of angular brightness distribution of the radiation source. Losses resulting from absorption in the reflector or reflection at the receiver are treated by a multiplicative factor rho alpha where rho equals reflectance of the reflector and alpha equals absorptance of the receiver. For numerical calculations, this method is more accurate and less time consuming than the ray tracing method. In many cases, there are acceptable approximations whereby the results can be obtained by reading a graph or evaluating a simple curve fit. DOE

N80-31918# Sandia Labs., Albuquerque, N. Mex. Thermal Subsystems Div.

#### THERMAL ENERGY STORAGE FOR SOLAR THERMAL APPLICATIONS PROGRAM Progress Report, Oct. 1979 -Mar. 1980

Lee G. Radosevich May 1980 100 p ref (Contract DE-AC04-76DP-00789) (SAND-80-8218) Avail: NTIS HC A05/MF A01

Developments in thermal energy storage technology are reported including: (1) storage for water/steam cooled collector receiver; (2) storage for molten salt cooled sensible heat collector/receiver: (3) storage for liquid metal cooled sensible heat collector/receiver; (4) storage for gas cooled sensible heat collector receiver; (5) storage for organic or silicone fluid cooled sensible heat collector/receiver; and (6) dish mounted latent heat buffer storage.

#### N80-31920# Boeing Co., Seattle, Wash. SOLAR PROJECT DESCRIPTION FOR SIR GALAHAD COMPANY, SINGLE FAMILY RESIDENCE, VIRGINIA BEACH, VIRGINIA

20 Jul. 1979 51 p

(Contracts EX-76-A-29-1020; HUD-H-2372)

(SOLAR/1028-79/50) Avail: NTIS HC A04/MF A01

A solar energy system designed to provide solar energy for space heating and domestic hot water heating is described. Solar energy is collected by an array of double glazed flat plate collectors with a gross area of 640 square feet. Solar energy is transferred from the collector array to a 1500 gallon above ground storage tank. Water is used as the heat collection, transfer and storage medium. Freeze protection is provided by means of circulation of hot water from storage through the collectors. Space heating demands are met by circulating hot water from storage through air heating coils in an air distribution system located in the house. Auxiliary space heating is provided by a heat pump and electric heater strips. Solar energy for preheating domestic hot water is provided by circulating water from the solar storage

tank through a water to water heat exchanger located solar storage tank. The dwelling has been fully instrumented for performance evaluation since October 1978. Original cost estimates for provisioning and installation of the solar system

N80-31921# Honeywell, Inc., Minneapolis, Minn. Technology Strategy Center.

DUAL CURVATURE ACOUSTICALLY DAMPED CONCEN-TRATING COLLECTOR Final Technical Report G. A. Smith and R. A. Rausch May 1980 348 p

(Contracts EM-78-C-04-4196; DE-AC04-78CS-34196) (DOE/CS-34196/T1) Avail: NTIS HC A15/MF A01

The design and performance parameters of a dual curvature. concentrating solar collector are investigated. The reflector of the solar collector is achieved with a stretched film reflective surface that approximates a hyperbolic paraboloid and is capable of line focusing at concentration ratios ranging from 10 to 20X. A prototype collector was designed based on analytical and experimental component trade off activities as well as economic analyses of solar thermal heating and cooling systems incororating this type of collector. A prototype collector incorporating six 0.66 x 1.22 m (2 x 4 ft) was fabricated and subjected to a limited thermal efficiency test program. A peak efficiency of 36% at 121 C (250 F) was achieved based upon the gross aperture area. Commercialization activities were conducted, including estimated production costs of \$134.44/sq m for the collector assembly (including a local suntracker and controls) and \$24.33/sq m for the reflector subassembly.

N80-31924# Sandia Labs., Albuquerque, N. Mex. Midtemperature Solar Subsystems Test Facility.

FIELD EXPERIENCE WITH SOLAR CONCENTRATING COLLECTOR CONTROL SYSTEMS

H. J. Gerwin 1980 4 p ref Presented at Joint Autom. Control Conf., San Francisco, 13 Aug. 1980 (Contract DE-AC04-76DP-00789)

CONF-800805-6) NTIS (SAND-79-2044C: Avail. HC A02/MF A01

Various types of solar concentrating collectors were tested and evaluated. Each collector type has a different control system that includes a Sun tracker sensor, fluid flow control, and safety circuits for equipment protection. The Sun tracker system sensors that were tested include shadow band, linear concentrated flux, computer driven (ephemeris), optical balance, and linear flux integration. Most of the systems evaluated were early development models and comparisons are made on the basis of field test conditions. Several fluid flow control approaches were included with the collectors. Generally, the fluid controls were designed to maintain a constant temperature by either varying the pump speed or a control valve. The safety circuits were designed to operate on signals such as overtemperature, insufficient fluid flow, and overtravel. Component failures and corrective actions are also discussed.

N80-31926# Midwest Research Inst., Golden, Colo. ANALYTICAL MODELING OF LINE FOCUS SOLAR COLLEC-TORS

John D. Wright Apr. 1980 8 p refs Presented at the Joint Autom. Control Conf., San Francisco, 13 Aug. 1980

(Contract EG-77-C-01-4042)

(SERI/TP-333-591: CONF-800805-1) NTIS Avail: HC A02/MF A01

Simplified models relating deviations in outlet temperature to changes in inlet temperature, insolation, and fluid flow rate are illustrated. The basic responses and the distributed parameter nature of line focus collectors are described. Detailed models were used to develop transfer functions and frequency response curves useful for design. DOE

N80-31928# Brookhaven National Lab., Upton, N. Y. ELECTROLYSIS-BASED HYDROGEN STORAGE TECHNOL-OGY

Gerald Strickland Nov. 1979 6 p Presented at the ANS Meeting, San Francisco, 12 Nov. 1979

(Contract DE-AC02-76CH-00016) (BNL-26923; CONF-791103-112) HC A02/MF A01

Avail:

NTIS

The major development areas deal with advanced water electrolysis systems, hydrogen storage materials and systems. and end-use applications. Work on hydrogen production deals with improving the system for KOH electrolysis, and on developing the acidic solid-polymer-electrolyte system for the electrolysis of water. The advantages of the techniques for storing hydrogen via metal hydrides and hollow glass microspheres are described. TiFe-based hydride was tested as an energy storage medium for electric energy storage, for automotive fuel, and for bulk hydrogen storage. Pairs of selected hydrides were used in tests simulating a solar-driven heat pump. The pressure-temperature characteristics of hydrides are being utilized in development of a hydrogen chemical compressor. Glass microspheres are being studied for the automotive fuel application.

N80-31930# FWG Associates, Inc., Tullahoma, Tenn. SUMMARY OF GUIDELINES FOR SITING WIND TURBINE GENERATORS RELATIVE TO SMALL-SCALE, DIMENSIONAL TERRAIN FEATURES Final Report Walter Frost and Dieter K. Nowal Mar. 1979 395 p refs (Contracts DE-AC06-77ET-20242; EY-76-C-06-2443) (RLO-2443-77/1) Avail: NTIS HC A17/MF A01

The terrain features considered are one or more surface roughness changes on otherwise flat terrain, shelterbelts or windbreaks, and bluff and smooth contoured hills. Estimates are given of the preferred wind turbine generators (WTG) location relative to these terrain features and of the resulting degradation in available wind power due to locating the WTG other than at the preferred site. The siting criteria are based on fluid mechanics analyses of somewhat idealized terrain geometries and prevailing atmospheric conditions. Therefore, the results presented show trends and order of magnitude effects rather than absolute values. The theoretical approach to analyzing the flow field and the reliability of the analytical assumptions for each terrain feature considered are discussed in their respective sections.

N80-31932# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

EVALUATION OF CONTROL STRATEGIES FOR SOLAR COLLECTOR LOOPS

Mashuri L. Warren, Steven R. Schiller, and Michael Wahlig Jun. 1980 15 p refs Presented at the Am. Sec. of the ISES Conf., Phoenix, Ariz., 2-6 Jun. 1980

(Contract W-7405-eng-48)

CONF-800604-22) (LBL-10716;

NTIS Avail:

HC A02/MF A01

Proportional and on/off controllers were evaluated and compared using a theoretical dynamic collector model. Control strategies using various flow rates, controller set points, insolation patterns, ambient temperature conditions, and collector types are evaluated. Energy collection efficiency, parasitic power consumption, pump cycling, and auxiliary heat usage are compared. DOE

N80-31933# Brookhaven National Lab., Upton, N. Y. of Energy and Environment.

SOLAR ASSISTED HEAT PUMP STUDIES: HEAT PUMP HARDWARE AND EXPERIMENTS, SIMULATIONS, EARTH COUPLING CONTRACTS AND SUPPORTING CONTRACTS Edward A. Kush 1980 6 p refs Presented at the Ann. DOE Active Solar Heating and Cooling Contractors Rev. Meeting, Incline, Nev., 26-28 Mar. 1980 Sponsored in Part by DOE (Contracts EY-76-C-02-0016; DE-AC02-76CH-00016) (BNL-27668) Avail: NTIS HC AO2/MF AO1

The status of the heat pump hardware development contracts, the results to date of the in house heat pumps experiments, the progress of the contractural effort in Earth coupling, and the activities of various supporting contracts are summarized.

DOE

N80-31941# Colorado State Univ., Fort Collins. Solar Energy Applications Lab.

RESIDENTIAL SOLAR HEATING AND COOLING USING EVACUATED TUBE SOLAR COLLECTORS: CSU SOLAR HOUSE 3, EXECUTIVE SUMMARY Final Report, 1 Feb. 1976 - 30 Sep. 1978

Dan S. Ward, John C. Ward, and H. S. Oberoi Mar. 1979 50 p refs

(Contract EY-76-C-02-2858)

(COO-2858-24) Avail: NTIS HC A03/MF A01

A residential solar heating and cooling system installed in Colorado State University (CSU) Solar House 3 is described. From 1 February 1976 through 31 May 1978 the CSU Solar House 3 system utilized the Owens-Illinois liquid heating evacuated tube solar collector. During the period 1 June 1978 through 30 September 1978, the Chamberlain liquid heating, state-of-the-art plate solar collector was evaluated for a complete cooling season.

N80-31942# Arizona State Univ., Tempe. School of Engineering.

TERRESTRIAL PHOTOVOLTAIC POWER SYSTEMS WITH SUNLIGHT CONCENTRATION

C. E. Backus and B. D. Wood Mar. 1980 191 p refs (Contract EY-76-C-04-0789).

(SAND-80-7008) Avail: NTIS HC A09/MF A01

Experiments were conducted on the flux uniformity and spectral distribution in the concentrated sunlight under a 1.08 meter. The preliminary data from these experiments show that the short circuit currents from a cell are directly proportional to the total illumination falling on the surface of the cell and not on the uniformity of the light profile. An available gallium aluminum arsenide cell was used with a hot mirror and a silicon cell to demonstrate that the efficiency of the combined system is greater than that achievable with the use of a single cell. An algorithm for calculating the electrical and thermal performance of a linear concentrated cell array developed. This computer program, based on quasi-steady state analysis, will calculate the array temperature and electrical outputs based on the day, time, transfer fluid inlet temperature and flow rate, ambient temperature, wind speed and direction, optical characteristics of the linear concentrator and solar irradiation. DOE

N80-31943# Aerospace Corp., El Segundo, Calif. Energy and Resources Div.

EVALUATION OF LINE FOCUS SOLAR CENTRAL POWER SYSTEMS. VOLUME 1: EXECUTIVE SUMMARY

15 Mar. 1980 28 p refs (Contract EY-76-C-03-1101)

(ATR-80(7773-03)-1-Vol-1) Avail: NTIS HC A03/MF A01

An evaluation was completed to ascertain the applicability of line focus technologies to electrical power applications and to compare their performance and cost potential with point focus central receiver power systems. Although the high temperature line focus and fixed mirror line focus concepts duplicate the heat source characteristics and power conversion technology of the central receiver concepts, these configurations do not offer a sufficient improvement in cost to warrant full scale development. The systems are less complex than their point focus counterpart and should the central receiver system development falter they provide reasonable technology alternatives.

N80-31944# Aerospace Corp., El Segundo, Calif. Energy Resources Div.

EVALUATION OF LINE FOCUS SOLAR CENTRAL POWER SYSTEMS. VOLUME 2: SYSTEMS EVALUATION

15 Mar. 1980 213 p refs (Contract EY-76-C-03-1101)

(ATR-80(7773-03)-1-Vol-2) Avail: NTIS HC A10/MF A01

An evaluation was completed to ascertain the applicability of line focus technologies to electrical power applications and to compare their performance and cost potential with point focus central receiver power systems. It was concluded that although the high temperature line focus and fixed mirror line focus concepts duplicate the heat source characteristics and power conversion technology of the central receiver concepts, these configurations

do not offer a sufficient improvement in cost to warrent full scale development. The systems are, however, less complex than their point focus counterpart and should the central receiver system development falter they provide reasonable technology alternatives. The parabolic trough concept was found to provide a low temperature technology alternative to the central receiver concept with promising performance and cost potential.

N80-31948# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

SOLAR CENTRAL RECEIVER HYBRID POWER SYSTEMS SODIUM-COOLED RECEIVER CONCEPT. VOLUME 1: EXECUTIVE SUMMARY Final Report

Jan. 1980 48 p refs

(Contract DE-AC03-78ET-20567)

(DOE/ET/20567-1/1; ESG-79-30-Vol-1) HC A03/MF A01

Avail: NTIS

Solar/fossil steam Rankine cycle, commercial scale, power plant systems are presented. Economical viability and technical feasibility of the systems is considered.

DOE

N80-31949# Aerospace Corp., El Segundo, Calif. Energy and Resources Div.

RESIDENTIAL PHOTOVOLTAIC SYSTEMS: A REVIEW AND COMPARATIVE EVALUATION OF FOUR INDEPENDENT STUDIES OF POTENTIAL CONCEPTS

Fred C. Finlayson Apr. 1980 75 p ref (Contract DE-AC04-76DP-00789)

(SAND-80-7010) Avail: NTIS HC A04/MF A01

Four independent studies of residential applications of photovoltaic generating systems were recently conducted by major industrial contractors: General Electric, Westinghouse, MIT-Lincoln Labs, and The Aerospace Corporation. The conclusions of the contractors had a number of important similarities and differences. An analysis of the several contractor's results, together with an identification of the sources of their similarities and differences is presented.

N80-31952# Ames Lab., lowa.
PHOTOELECTROCHEMICAL SOLAR CELLS BASED ON D-BAND ELECTROCHEMISTRY AT TRANSITION METAL DISELENIDES Technical Progress Report, 14 Aug. - 30 Nov.

Thomas E. Furtak and Bruce A. Parkinson Feb. 1980 20 p

(Contracts W-7405-eng-82; EG-77-C-01-4042) (IS-4724) Avail: NTIS HC A02/MF A01

Successful growth of WSe2 crystals led to the production of photocells which operate with greater than 5 percent monochromatic power conversion efficiency in I(-)/I2 solution. Scanning light spot maps were used to identify and evaluate inhomogeneities across the surface and to serve as a reference for the edge passivation program which helped improve performance significantly. Results are discussed.

N80-31953# University of Southern California, Los Angeles. Dept. of Materials Science.

LOW COST SOLAR CELLS BASED ON AMORPHOUS SILICON ELECTRODEPOSITED FROM ORGANIC SOLVENTS Final Technical Report, 1 Sep. 1978 - 31 Aug. 1979

F. A. Kroeger 1979 34 p (Contract EY-76-S-03-0113)

(SAN-0113-040-T6) Avail: NTIS HC A03/MF A01

A variety of silicon compounds were chosen for electrolysis experiments viz, silicon tetrachloride, silicon tetrabromide, tetraethylorthosilicate, potassium hexafluoro silicate and ammonium hexafluoro silicate. These compounds are dissolved in non aqueous solvents, acetone, acetic acid, ethylene glycol, propylene glycol, propylene carbonate, pyridine, ethylene diamine, 1-chloropropane, formamide, N-Ndi methyl formamide, etc. Where the conductivity of the solutions is low, supporting electrolytes like tetrabutyl ammonium chloride, bromide or perchlorate are added. The electrolysis was carried out using, silicon nickel, conducting, glass, stainless-steel or copper cathodes, graphite,

platinum or silicon anodes and saturated calomel or Ag/AgCl as reference electrodes.

N80-31954# Sandia Labs., Albuquerque, N. Mex. Solar Energy Systems Analysis

ANALYTICAL EVALUATION OF A SOLAR THERMOPHO-**TOVOLTAIC CONVERTER** 

Michael W. Edenburn May 1980 30 p refs (Contract DE-AC04-76DP-00789)

(SAND-78-1962) Avail: NTIS HC A03/MF A01

A solar thermophotovoltaic (TPV) converter uses concentrated sunlight to heat a cavity-enclosed emitter to a few thousand degrees kelvin. The emitter illuminates photovoltaic cells with thermal radiation, and the cells convert the radiation into electricity. Emitter temperature, cell reflectance to radiation with energy below the cell's bandgap energy, and concentration ratio requirements are parametrically considered. Concentration ratio is treated in a rigorous manner to determine what concentration values can be practically achieved and what influence they have on converter performance. Important conclusions reached are that an emitter temperature of 2000 K is close to optimum and a cell reflectance value of 0.98 is required for below bandgap radiation. A secondary concentrator must be used and a primary mirror quality resulting in a 4 milliradian reflected-beam dispersion must be obtained to achieve a 24% conversion efficiency. DOE

N80-31955# South Dakota Univ., Vermillion.

PASSIVE SOLAR HEATING OF BUILDINGS WITH AT-TACHED GREENHOUSE Progress Report, 29 Feb. - 29 Apr.

Robert W. Jones Apr. 1980 28 p (Contract DE-AC02-79CS-30242)

(DOE/CS-30242/2) Avail: NTIS HC A03/MF A01

The thermal performance of attached greenhouse buildings analyzed in order to determine the component sizes and configurations which optimize performance. The analytical method is dynamic computer simulation using a thermal network model and actual hourly meteorological and solar radiation data from the northcental region. Conclusions on design guidelines are discussed.

N80-31962# Centro Informazioni Studi Esperienze, Milan (Italy). Servizio Documentazione.

GALLIUM ARSENIDE SOLAR CELLS FOR VERY HIGH CONCENTRATION SYSTEMS: RECENT RESULTS, PROB-LEMS AND EXPECTATIONS [CELLE SOLARI AL-L'ARSENIURO DI GALLIO PER SISTEMI AD ALTISSIMA CONCENTRAZIONE: RISULTATI RECENTI, PROBLEMI E PROSPETTIVE]

G. Guarini Oct. 1979 12 p refs In ITALIAN Presented at Conf. on Conversione Foltovoltaica dell'Energia Solar, Milan, 18-19 Oct. 1979

(CISE-1518). Avail: NTIS HC A02/MF A01

The state-of-the-art of solar cell research for use under highly concentrated solar radiation is reviewed. The application of GaAlAs-GaAs cells, systems using thermal recovery, and research on multi-energy levels are discussed. It is concluded that high concentration systems based on GaAlAs multicolor cells with efficiency over 30% appear to be attractive and economically feasable solutions. The three junction monolithic cell (efficiency 40-45%) is an important research goal.

Author (ESA)

N80-31963\*# New Mexico Univ., Albuquerque. Technology Application Center.

SOLAR THERMAL HEATING AND COOLING. A BIBLIOG-RAPHY WITH ABSTRACTS Quarterly Progress Report, Apr. - Jun. 1979

Mike Arenson Aug. 1979 207. p

(Contract NASw-2936)

(NASA-CR-163535; PB80-174030; TAC-STHC-79-002) Avail: NTIS HC \$27.50/MF \$27.50 CSCL 13A

This bibliographic series cites and abstracts the literature and technical papers on the heating and cooling of buildings with solar thermal energy. Over 650 citations are arranged in

the following categories: space heating and cooling systems: space heating and cooling models; building energy conservation; architectural considerations, thermal load computations; thermal load measurements, domestic hot water, solar and atmospheric radiation, swimming pools; and economics.

N80-31966# Patent and Trademark Office, Washington, D. C. Office of Technology Assessment and Forecast. PATENT PROFILES: SOLAR ENERGY

Jan. 1980 195 p

(PB80-190010) Avail: NTIS HC A09/MF A01 CSCL 10A Profiles of United States patenting in five major areas of solar energy technology, and in the related areas of wind, geothermal and tide and wave energy are presented. A list of assignees ranked by the number of patents in the technology to which they held title at the time of the patent grant is provided. Assignees are listed alphabetically followed by a numerical listing of patents to which they held title at the time of patent grant.

N80-31967# Utah Water Research Lab., Logan. Coll. of Engineering.

#### **DESIGN OF A COST EFFECTIVE SOLAR POWERED WATER** PUMP

Duane G. Chadwick Apr. 1980 44 p refs (Contract DI-14-34-0001-8047)

(PB80-182819; UWRL/H-80-02; W80-05011; OWRT-A-036-UTAH-1) Avail: NTIS HC A03/MF A01 CSCL

The basic design consists of an expanding gaseous piston confined inside a chamber which is located in series with, and between, an inlet and an outlet check valve. The gas is generated by volatilizing cyclopentane or hexane. Four variations of this basic design concept were built and evaluated. Considerations in the choice of a cost effective solar collector are also reviewed. A 70 C heat source temperature is required to operate the pump if cyclopentane is used as the volatile fluid, 90 C is required if hexane is used. The pumps have a capacity of approximately 6 liters/minute when pumped to a height of 2 meters. Two square meters of sunshine are sufficient to operate the pump.

N80-31975# Automation Industries, Inc., Silver Spring, Md. Vitro Labs. Div.

ENVIRONMENTAL DATA FOR SITES IN THE NATIONAL SOLAR DATA NETWORK Progress Report, Feb. 1980 Feb. 1980 221 p

(Contract DE-AC01-79CS-30027)

(SOLAR/0010-80/02) Avail: NTIS HC A10/MF A01

The network consits of (1) sensors which measure key performance parameters at a selected site; (2) a Site Data Acquisition System (SDAS); (3) telephone transmission circuits; and (4) a Central Data Processing System (CDPS). Sensor data are collected and stored on a cassette tape in the SDAS. The CDPS collects and processes the information and performs the required computations. For the majority of parameters, raw data is collected approximately every five minutes. Solar insolation and certain other parameters, which are subject to rapid variance, are sampled every 32 seconds. The CDPS interrogates each SDAS on a daily basis and retrieves all accumulated data. At the conclusion of data retrieval, the SDAS Cassette is reset by command from the CDPS for continuing data collection. Environmental information collected at the sites for the reporting month are presented. Only those sites for which the data are found to be valid are reported.

N80-32410\* National Aeronautics and Space Administration, Washington, D. C.

TECHNOLOGY FOR LARGE SPACE SYSTEMS. A SPECIAL BIBLIOGRAPHY WITH INDEXES, SUPPLEMENT 3 Jul. 1980 85 p

(NASA-SP-7046(03)) Avail: NTIS HC \$8.00 CSCL 22A

A bibliography containing 217 abstracts addressing the technology for large space systems is presented. State of the art and advanced concepts concerning interactive analysis and

#### **02 SOLAR ENERGY**

design, structural concepts, control systems, electronics, advanced materials, assembly concepts, propulsion, solar power satellite systems, and flight experiments are represented.

M.G.

N80-32527# Westinghouse Electric Corp., Pittsburgh, Pa. Research and Development Center.

COLLECTOR SEALANTS AND BREATHING Final Report, 25 Sep. 1978 - 31 Dec. 1979

M. A. Mendelsohn, R. M. Luck, F. A. Yeoman, and F. M. Navish, Jr. 20 Feb. 1980 278 p refs (Contract DE-AC04-78CS-15362)

(DOE/CS-15362/1) Avail: NTIS HC A13/MF A01

The pertinent properties of a variety of possible sealants for solar collectors were investigated, the most promising candidates were identified, and the effect of breathing in flat plate, thermal solar collector units was studied. Two types of sealants, Class PS which includes preformed seals or gaskets and Class SC which includes sealing compounds or caulks were considered. Environmental stresses evaluated include elevated temperatures, moisture, ultraviolet light, ozone and oxygen, and fungus. Factors such as design, fabrication, materials of construction, seals and sealing techniques and absorber plate coatings were observed on actual field units removed from service. Such phenomena as leakage, corrosion and formation of deposits on glazing and absorber plate were noted. The properties of several desiccants were evaluated in order to provide means to mitigate the deleterious effects of water on collector life. Adsorbents for organic degradation products of sealants were also investigated in order to protect the glazing and absorber plate from deposited DOF coatings.

N80-32790# General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.

## MEAN WIND FORCES ON PARABOLIC-TROUGH SOLAR COLLECTORS

J. A. Peterka (Colorado State Univ.), J. M. Sinau (Colorado State Univ.), and J. E. Cermak (Colorado State Univ.) May 1980 121 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-7023) Avail: NTIS HC A06/MF A01

Characteristics of mean wind loads produced by airflow in and around several configurations of parabolic trough solar collectors with and without a wind fence are discussed. Four basic parabolic shapes were investigated as single units and one shape was studied as part of several array fields. One scale model of each parabolic shape was constructed for mounting on a force balance to measure two forces and three moments. The effects of several dominant variables were investigated in this study: wind-azimuth (or yaw), trough elevation (or pitch) angle, array field configuration, and protective wind fence characteristics. All measurements were made in a boundary layer flow.

N80-32850\*# National Aeronautics and Space Administration. Pasadena Office. Calif.

IMPROVING THE EFFICIENCY OF SILICON SOLAR CELLS CONTAINING CHROMIUM Patent Application

Amal M. Salama, inventor (to NASA) (JPL) Filed 11 Sep. 1980 16 p

(Contract NAS7-100)

(NASA-Case-NPO-15179-1; US-Patent-Appl-SN-185867) Avail: NTIS HC A02/MF A01 CSCL 10A

Efficiency of silicon solar cells containing about 10 to the 15th power atoms/cu cm of chromium is improved about 26% by thermal annealing of the silicon wafer at a temperature of 200 C to form chromium precipitates having a diameter of less than 1 Angstrom. Further improvement in efficiency is achieved by scribing laser lines onto the back surface of the wafer at a spacing of at least 0.5 mm and at a depth of less than 13 micrometers to preferentially precipitate chromium near the back surface and away from the junction region of the device. This provides an economical way to improve the deleterious effects of chromium, one of the impurities present in metallurgical grade silicon material.

N80-32851\*# ARATEX Services, Inc., Encino, Calif.
SOLAR HOT WATER DEMONSTRATION PROJECT AT RED
STAR INDUSTRIAL LAUNDRY, FRESNO, CALIFORNIA Final
Report

Jul. 1980 82 p Sponsored in part by NASA. Marshall Space Flight Center

(Contract EX-76-C-01-2384)

(NASA-CR-161537) Avail: NTIS HC A05/MF A01 CSCL 10A

The performance of a Solar Hot Water System at a laundry in Fresno. Califironia is described. The system features an integrated wastewater heat recovery subsystem and a solar preheating system designed to supply a part of the hot water requirements. Performance data for a six month period are projected to an annual savings of \$18,703.

N80-32852\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

LOW-COST SOLAR ARRAY PROJECT AND PROCEEDINGS OF THE 15TH PROJECT INTEGRATION MEETING Progress Report, Dec. 1979 - Apr. 1980

Apr. 1980 .385 p Meeting held on 2-3 Apr. 1980 (Contracts NAS7-100: EX-76-A-29-1012) (NASA-CR-163568; DOE/JPL-1012-44; JPL-Pub-80-

(NASA-CR-163568; DOE/JPL-1012-44; JPL-Pub-80-27; PR-15) Avail: NTIS HC A17/MF A01 CSCL 10A

Progress made by the Low-Cost Solar Array Project during the period December 1979 to April 1980 is described. Project analysis and integration, technology development in silicon material, large area silicon sheet and encapsulation, production process and equipment development, engineering, and operation are included.

R.K.G.

N80-32853\*# Rice Univ., Houston, Tex. Dept. of Space Physics and Astronomy.

A COMPUTER MODEL OF SOLAR PANEL PLASMA INTERACTIONS Final Report

David L. Cooke and John W. Freeman [1980] 59 p refs (Contract NAS9-15796)

(NASA-CR-160796) Avail: NTIS HC A04/MF A01 CSCL

High power solar arrays for satellite power systems are presently being planned with dimensions of kilometers, and with tens of kilovolts distributed over their surface. Such systems face many plasma interaction problems, such as power leakage to the plasma, particle focusing, and anomalous arcing. These effects cannot be adequately modeled without detailed knowledge of the plasma sheath structure and space charge effects. Laboratory studies of 1 by 10 meter solar array in a simulated low Earth orbit plasma are discussed. The plasma screening process is discussed, program theory is outlined, and a series of calibration models is presented. These models are designed to demonstrate that PANEL is capable of accurate self consistant space charge calculations. Such models include PANEL predictions for the Child-Langmuir diode problem.

N80-32855\*# Burt, Hill, Kosar, Rittleman, and Associates, Butler, Pa. Research and Solar Applications Div.

OPERATION AND MAINTENANCE COST DATA FOR RESIDENTIAL PHOTOVOLTAIC MODULES/PANELS Final Report

J. R. Oster, Jr., D. R. Zaremski, Jr., E. M. Albert, and S. L. Hawkins Jul. 1980 106 p refs (Contract JPL-955614)

(NASA-CR-163585: DOE/JPL-955614-80/1: JPL-9950-408) Avail: NTIS HC A06/MF A01 CSCL 10A

Costs associated with the operation and maintenance of residential photovoltaic modules and arrays are studied. Six basic topics related to operation and maintenance to photovoltaic arrays are investigated: maintenance: cleaning: panel replacement: gasket repair/replacement; wiring repair/replacement: and termination repair/replacement. The effects of the mounting types (rack mount, stand off mount, direct mount and integral mount) and the installation/replacement type (sequential, partial interruption and independent) are identified and described. Methods of reducing maintenance costs are suggested.

S.F.

N80-32857\*# Rockwell International Science Center, Thousand Oaks. Calif.

STUDY PROGRAM FOR ENCAPSULATION MATERIALS INTERFACE FOR LOW COST SILICON SOLAR ARRAY Annual Report, 1 Jan. - 31 Dec. 1979

D. H. Kaelble, F. B. Mansfeld, J. B. Lunsden, III, and C. Leung Mar. 1980 88 p refs (Contracts JPL-954739; N00014-75-C-0788; NR Proj.

036-108)

(NASA-CR-163583; DOE/JPL-954739-3; SC5106.86AR; JPL-9950-416; AR-1) Ávail: NTIS HC A05/MF A01 CSCL

An atmospheric corrosion model was developed and verified by five months of corrosion rate and climatology data acquired at the Mead, Nebraska LSA test site. Atmospheric corrosion rate monitors (ACM) show that moisture condensation probability and ionic conduction at the corroding surface or interface are controlling factors in corrosion rate. Protection of the corroding surface by encapsulant was shown by the ACM recordings to be maintained, independent of climatology, over the five months outdoor exposure period. The macroscopic corrosion processes which occur at Mead are shown to be reproduced in the climatology simulator. Controlled experiments with identical moisture and temperature aging cycles show that UV radiation causes corrosion while UV shielding inhibits LSA corrosion.

R.K.G.

N80-32859\*# Rockwell International Corp., Downey, Calif. SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 6: IN-DEPTH ELEMENT INVESTIGATION Final Contractor Report

G. M. Hanley Sep. 1980 97 p refs (Contract NAS8-32475)

(NASA-CR-3323; SSD-79-0010-6) NTIS HC A05/MF A01 CSCL 10A

The fabrication parameters of GaAs MESFET solid-state amplifiers considering a power added conversion efficiency of at least 80% and power gains of at least 10dB were determined. Operating frequency was 2.45 GHz although 914 MHz was also considered. Basic circuit to be considered was either Class C or Class E amplification. Two modeling programs were utilized. The results of several computer calculations considering differing loads, temperatures, and efficiencies are presented. Parametric data in both tabular and plotted form are presented.

N80-32860\*# Rockwell International Corp., Downey, Calif. SATELLITE POWER SYSTEM (SPS) CONCEPT DEFINITION STUDY. VOLUME 3: EXPERIMENTAL VERIFICATION **DEFINITION Final Contractor Report** 

G. M. Hanley Sep. 1980 145 p (Contract NAS8-32475)

SSD-79-0010-3) (NASA-CR-3320: Avail: NTIS HC A07/MF A01 CSCL 10A

An evolutionary Satellite Power Systems development plan was prepared. Planning analysis was directed toward the evolution of a scenario that met the stated objectives, was technically possible and economically attractive, and took into account constraining considerations, such as requirements for very large scale end-to-end demonstration in a compressed time frame, the relative cost/technical merits of ground testing versus space testing, and the need for large mass flow capability to low Earth orbit and geosynchronous orbit at reasonable cost per pound.

NTIS

N80-32861\*# Rockwell International Corp., Downey, Calif. SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 5: SPECIAL EMPHASIS STUDIES Final Report

G. M. Hanley Sep. 1980 265 p refs (Contract NAS8-32475)

(NASA-CR-3322; SSD-79-0010-5)

HC A12/MF A01 CSCL 10A

Satellite configurations based on the Satellite Power System baseline requirements were analyzed and a preferred concept selected. A satellite construction base was defined, precursor operations incident to establishment of orbital support facilities

identified, and the satellite construction sequence and procedures developed. Rectenna construction requirement were also addressed. Mass flow to orbit requirements were revised and traffic models established based on consutrcution of 60 instead of 120 satellites. Analyses were conducted to determine satellite control, resources, manufacturing, and propellant requirements. The impact of the laser beam used for space-to-Earth power transmission upon the intervening atmosphere was examined as well as the inverse effect. The significant space environments and their effects on spacecraft components were investigated to define the design and operational limits imposed by the environments on an orbit transfer vehicle. The results show that LEO altitude < 300 nmi and transfer orbit duration < 6 months are preferrable. J.M.S.

N80-32863# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

USE OF SOLAR ENERGY TO PRODUCE PROCESS HEAT FOR INDUSTRY

Ken Brown Apr. 1980 28 p refs Presented at the 30th Ann. Plant Eng. and Maintenance Conf., Chicago, 24 Mar. 1980

(Contract EG-77-C-01-4042)

(SERI/TP-731-626; CONF-800373-1) Avail: HC A03/MF A01

The role of solar energy in supplying heat and hot water to residential and commerical buildings is familiar. On the other hand, the role that solar energy may play in displacing imported energy supplies in the industrial and utility sectors often goes unrecognized. The versatility of solar technology lends itself well to applications in industry; particulary to the supplemental supply for process heat. The status of solar thermal technology for industrial process heat applications, including a description of current costs and operating histories is surveyed. The most important objectives to be met in improving system performance, reducing cost, and identifying markets for solar industrial process DOE heat are outlined.

N80-32885# New Mexico Univ., Albuquerque, Mechanical Engineering. ANALYSIS OF A PASSIVE HEAT PIPE COOLED SOLAR PHOTOVOLTAIC RECEIVER

K. T. Feldman, Jr. and D. D. Kenney May 1980 97 p refs Prepared in cooperation with Energy Engineering, Inc., Albuquerque, N. Mex. Prepared for Sandia Labs., Albuquerque, N. Mex. (Contract DE-AC04-76DP-00789)

(SAND-80-7011) Avail: NTIS HC A05/MF A01

A design study to analyze the performance of an aluminum heat pipe for passive cooling of photovoltaic cells is presented. The heat pipe vessel is an aluminum extrusion with a wedge shaped cross section. The solar cells are mounted on the lower surface where they are irradiated by a parabolic trough solar concentrator. The maximum solar cell temperature is 140 C. Heat is removed from the condenser surface by convection to the ambient air at 40 C. Working fluid selection, heat pipe analysis, and method of performance calculations are described.

N80-32887# Sandia Labs., Albuquerque, N. Mex. Solar Energy Projects Dept.

LINE-FOCUS SOLAR THERMAL ENERGY TECHNOLOGY **DEVELOPMENT. REPORT FOR DEPARTMENT 4720 Annual** 

Kenneth D. Bergeron, ed., Roscoe L. Champion, ed., and Robert W. Hunke, ed. Apr. 1980 144 p refs (Contract DE-AC04-76DP-00789) (SAND-80-0865-Rev) Avail: NTIS HC A07/MF A01

The primary role of the Solar Energy Projects Department 2 is the development, evaluation, and testing of lime focus solar thermal technology. This report is divided into two parts: (1) component and subsystem development including the design and analysis of collector modules, their components, and associated materials and processes; and (2) systems and applications development, involving larger configurations of solar thermal line focus systems. The emphasis is on parabolic troughs, but significant efforts on hemispherical bowls, compound parabolic collectors, and dishes for the Solar Total Energy Project are also described.

N80-32889# Rocket Research Corp., Redmond, Wash.
CHEMICAL ENERGY STORAGE FOR SOLAR THERMAL
CONVERSION Final Report

Richard D. Smith, D. R. Poole, C. H. Li, D. K. Carlson, and D. R. Peterson 27 Apr. 1979 99 p refs

(Contract DE-AC04-76DP-00789)

(SAND-79-8198; RRC-80-R-678)

Avail: NTIS

HC A05/MF A01

The technical and economic aspects of using reversible chemical reactions to store energy in Solar Thermal Electric Conversion (STEC) facilities were studied. The study included identification of nine promising chemical reactions from a list of over 550 candidates, preliminary process designs of energy storage subsystems based on these nine reactions, and extensive systems studies of autonomous and hybrid STEC plants with energy storage subsystems based on the reversible oxidation of SO2. The systems studies used a detailed simulation, based ona year long, hour by hour energy balance, of a central receiver STEC facility. Over a range of alternate energy cost and geographic location, the optimum busbar energy costs from autonomous STEC plants were 15 to 90% higher than those from hybrid plants. Optimum storage requirements of autonomous STEC plants were in the range of 200 to 400 hours, while those for hybrid DOE " plants were in the range of 15 to 30 hours.

N80-32890# ARCO Solar, Inc., Chatsworth, Calif.
DESIGN AND FABRICATION OF COMBINED PHOTOVOLTAIC-THERMAL COLLECTORS

May 1980' 54 p (Contract DE-AC04-76DP-00789)

(SAND-79-7008) Avail: NTIS HC A04/MF A01

Two water-cooled and two air-cooled modules were designed, fabricated, and tested. Module designs were developed which effectively combined photovoltaic cell and module technology with solar thermal module technology, with minimum modification. The combined modules were designed to be mechanically interchangeable with production solar thermal modules. This design approach was selected to minimize installation and reliability problems, and to reduce costs of combined modules by minimizing new tooling requirements. Both the electrical and thermal performance of the experimental modules was lower than calculated during the design phase of the program, and lower than required by the Sandia specification.

N80-32891# BDM Corp., McLean, Va. PHOTOVOLTAIC APPLICATIONS DEFINITION AND PHOTOVOLTAIC SYSTEM DEFINITION STUDY IN THE AGRICULTURAL SECTOR. VOLUME 3. APPENDIXES Final Report

R. W. Mengel, T. P. Nadolski, D. C. Sparks, S. K. Young, and A. Yingst May 1980 221 p refs (Contract DE-AC04-76DP-00789)

(SAND-79-7018/3) Avail: NTIS HC A10/MF A01

A description of energy consumption for representative farm operations, design and simulation of ventilation for livestock shelters; irrigation systems and calculations; and detailed methodology for selecting multifunction PV system applications are presented. Hourly load data for the chosen farm operations; sample linear programming solution output format; life cycle cost calculation; and illustrative monthly load data for applications analysis and equipment data for applications analysis are also discussed.

N80-32892# Barber-Nichols Engineering Co., Arvada, Colo. SOLAR POWERED RANKINE CYCLE IRRIGATION PUMP Final Report

William D. Batton and Robert E. Barber Sep. 1979 87 p. refs

(Contract DE-AC03-78ET-20419)

(DOE/ET-20419/1: SAN-0419-1) Avail: NTIS

HC Á05/MF AÓ1

Results of a test program where a small (288 square feet) collector field was installed and used for boiling-in-the-collector

tests with R-113 as a working fluid are presented. Two different types of parabolic trough tracking collectors were purchased and tested. There were two rows (128 sq ft) of Del Manufacturing collectors and one row (160 sq ft) of Solar Kinetics collectors. All three rows were installed at a 5 degree angle (inclined to the South) oriented North-South and tracking East-West on the roof at Barber-Nichols in Arvada, Colorado. These two types of collectors have distinct differences that made it worthwhile to test each type. A Rankine engine, less turbine expander, was installed and used to complete a solar power system. The major experimental results are that the collectors did heat the R-113, did provide a vapor suitable for turbine feed, and stable flow did occur under all conditions, thus proving the feasibility of the boiling-in-collector concept.

N80-32894# Sandia Labs., Albuquerque, N. Mex. Solar Energy Projects Dept.

FLUID TEMPERATURE CONTROL FOR PARABOLIC TROUGH SOLAR COLLECTORS

Rudolph Schindwoff 1980 27 p refs Presented at the Joint Autom. Control Conf., San Francisco, 13 Aug. 1980 (Contract DE-AC04-76DP-00789)

(SAND-79-2006C: CONF-800805-2)

Avail: NTIS

HC A03/MF A01

Techniques for controlling the temperature of the heat transfer fluid in parabolic trough solar collectors fields were studied by computer simulation. In particular, the rather stringent temperature control requirements associated with thermal electric power generation or cogeneration systems are addressed. Computer models representing the fluid temperature dynamics of the collectors and interconnecting piping were developed and integrated with dynamic models of control elements to obtain a closed loop control system simulation. A specific control configuration was chosen consisting of a flow control valve and one or more temperature sensors to control the flow in each row of collectors. Various control algorithms were evaluated for stability and static errors, and time responses to startup transients and to partial and full collector cloud shadowing transients were obtained. The results indicated that the temperature control requirements can be satisfied using readily available components. DOE

N80-32895# Sandia Labs., Albuquerque, N. Mex. Experimental Aerodynamics Div.

### PARABOLIC TROUGH SOLAR COLLECTOR WIND LOADING

Duane E. Randall, Donald D. McBride, and Roger E. Tate 1980 54 p refs Presented at the ASME Century 2 Emerging Technol. Conf., San Francisco, 18-20 Aug. 1980 (Contract DE-AC04-76DP-00789)

(SAND-79-2134C; CONF-800804-16) Avail: NTIS HC A04/MF A01

Two wind tunnel force and moment tests conducted on parabolic trough solar collector configurations are discussed. The two tests were conducted in different flow field environments, one a uniform flow infinite airstream, the second a simulated atmospheric boundary layer flow with the models simulating a ground mounted installation. The force and moment characteristics of both isolated single module troughs and of trough modules within array configurations were defined over both operational and stow attitudes. The influence of various geometric design parameters for collector modules and arrays was established. Data indicate that forces and moments increase with mounting height and with trough aspect ratio. Collector modules interior to large arrays experience wind force reductions as high as 50 to 65%, while appropriate fences or berms surrounding the arrays can provide exterior modules with protection of this order. DOE

N80-32896# Chicago Univ., III.

FUNDAMENTALS AND TECHNIQUES OF NONIMAGING OPTICS FOR SOLAR ENERGY CONCENTRATION Final Report

Roland Winston and Joseph J. Gallagher 20 May 1980 51 p refs

(Contract DE-AS02-78ER-04657)

(DOE/ER-04657/2) Avail: NTIS HC A04/MF A01

The properties of a variety of new and previously known nonimaging optical configurations were investigated. A thermodynamic model which explains quantitatively, the enhancement of effective absorptance of gray body receivers through cavity effects was developed. The classic method of Liu and Jordan, which allows one to predict the diffuse sunlight levels through correlation with the total and direct fraction was revised and updated and applied to predict the performance of nonimaging solar collectors. The conceptual design for an optimized solar coolector which integrates the techniques of nonimaging concentration with evacuated tube collector technology was carried out and is presently the basis for a separately funded hardware development project.

N80-32913# Texas Univ. at Austin. Center for Energy Studies.

MONITORING OF THE PERFORMANCE OF A SOLAR HEATED AND COOLED APARTMENT BUILDING Final Report

Gary C. Vliet and Robert L. Srubar Mar. 1980 95 p refs (Contract EM-78-S-01-5235)

(DSE-5235-T1) Avail: NTIS HC A05/MF A01

An all electric apartment building in Texas was retrofitted for solar heating and cooling and hot water. The system consisted of an array of 1280 square feet of Northrup concentrating tracking collectors, a 5000 gallon hot water storage vessel, a 500 gallon chilled water storage vessel, a 25 ton Arkla Industries absorption chiller, and a two pipe hydronic air conditioning system. The solar air conditioning equipment was installed in parallel with the existing conventional electric heating and cooling system, and the solar domestic water heating served as preheat to the existing electric water heaters. The system was fully instrumented for monitoring. Detailed descriptions of the solar system, the performance monitoring system, and the data reduction processes are given.

N80-32914# Lincoln Lab., Mass. Inst. of Tech., Lexington.
ANALYTICAL PREDICTION OF THE PERFORMANCE OF
AN AIR PHOTOVOLTAIC/THERMAL FLAT PLATE.COLLECTOR

P. Raghuraman 30 Apr. 1980 20 p refs (Contract DE-AC02-76ET-20279)

(DOE/ET-20279/93) Avail: NTIS HC A02/MF A01

A one dimensional analysis predicted the electrical and thermal performance of an air photovoltaic/thermal flat plate collector. The analysis compared well with test measurements, predicting the thermal efficiency to within 2 percent. From the analysis, the poor thermal performance of the collector was attributable, in part, to the large undulations of the cell/silicon pottant surface in contact with the flowing air that resulted in less effective convective heat transfer areas between the cell and the air DOE

N80-32916# Joint Center for Graduate Study, Richland, Wash. [INVESTIGATION OF LOW-COST SOLAR CELLS BASED ON Cu2O] Quarterly Progress Report, 1 Nov. 1979 - 31 Jan. 1980

Larry C. Olsen 12 Mar. 1980 33 p refs (Contract DE-AC04-79ET-23006)

(DOE/ET-23006/3; QPR-3) Avail: NTIS HC A03/MF A01 In-doped ZnS films with very good optical quality and finite conductivity were obtained by codepositing In and ZnS. Analysis of the internal photoresponse indicated that minority carrier diffusion lengths on the order of 10 micrometers are being achieved with the present Cu20 growth procedure. These devices appear to have an MIS structure or fixed charge at the interface. Another very significant achievement was the development of a surface preparation procedure which results in a nearly perfect stochiometry at the surface.

N80-32916# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

SPECTRAL CHARACTER OF SOLAR AND CIRCUMSOLAR RADIATION

D. B. Evans, D. F. Grether, A. J. Hunt, and M. Wahlig Mar. 1980 6 p refs Presented at the ISES Conf., Phoenix, Ariz., 2 Jun. 1980 (Contract W-7405-eng-48) (LBL-10802: CONF-800604-25) HC A02/MF A01

Avail: NTIS

Information on the solar and circumsolar radiation (the solar aureole) for application to concentrating solar energy systems is discussed. Four instrument systems obtain detailed measurements of the solar and circumsolar intensity, both as a function of angular distance from the center of the Sun, and as a function of wavelength. A method of inverting filtered measurements to obtain the energy contained within a given wavelength interval is presented. Comparisons are made between the atmospheric transmission code LOWTRAN and normal incidence data. The amount of circumsolar radiation and the dependence of circumsolar radiation on angular distance from the Sun are discussed as a function of wavelength for selected atmospheric conditions. DOE

N80-32919# Virginia Polytechnic Inst. and State Univ... Blacksburg.

CdSiAs2 THIN FILMS FOR SOLAR CELL APPLICATIONS Quarterly Report, 9 Apr. - 30 Jun. 1979

L. C. Burton and L. H. Slack 25 Jul. 1979 51 p refs (Contract DE-AC04-79ET-23007)

(DOE/ET-23007/1) Avail: NTIS HC A04/MF A01

Near stoichiometric bulk polycrystalline CdSiAs2 was synthesized by two techniques: (1) direct fusion of the elements and (2) direct fusion of the binaries SiAs, Cd3As2 and CdAs2. The latter technique resulted in denser ternary material with good homogeneity. The above binaries melt congruently and were also formed by direct fusion. Sputtered ternary films were formed. using a bulk CdSiAs2 target, and a composite target of CdAs2 discs in a Si plate. Composition of the CdSiAS2 target changed with sputtering time. Amorphous films deposited from that target were heat treated, and became crystalline and near stoichiometric but with poor mechanical properties. It appears that films deposited from the composite target (Si + CdAs2) can be adjusted to stoichiometry by means of sputtering power and target geometry. As deposited, these films also were amorphous. DOF

N80-32920# State Univ. of New York, Buffalo. Dept. of Electrical Engineering.

DEPOSITION, FABRICATION AND ANALYSIS OF POLY-CRYSTALLINE SILICON MIS SOLAR CELLS Final Report; 1 Jan. - 31 Dec. 1979

Wayne A. Anderson Mar. 1980 112 p refs

(Contract DE-AC03-79ET-23044)

(DOE/ET-23044/4) Avail: NTIS HC A06/MF A01

MIS cell fabrication techniques, protovoltaic response data. I-V-T analysis to reveal conduction mechanisms, a detailed computer model, optimum MIS solar cell design, surface state effects, Auger studies, reliability studies and e-beam deposition of thin silicon films are discussed. The most important features include the one pump down fabrication process, establishing a consistent fabrication sequence, achieving 13% efficiency of 2 sq cm area, an evaluation of conduction mechanisms, establishing a detailed computer model, and setting up an improved e-beam system to deposit thin silicon films.

N80-32921# RCA Labs., Princeton, N. J. Display and Energy Systems Research Lab.

AMORPHOUS THIN FILMS FOR SOLAR-CELL APPLICATIONS Final Report

D. E. Carlson, R. W. Smith, I. Balberg, R. S. Crandall, B. E. Thompkins, J. Dresner, B. C. Goldstein, D. J. Szostak, J. J. Hanak, J. P. Pellicane et al. Feb. 1980 176 p. refs (Contract DE-AC03-78ET-21074)

(DOE/ET-21074/4; PRRL-79-CR-47) Avail: NTIS HC A09/MF A01

Theories for the capture of electrons by deep centers in hydrogenated amorphous silicon (a-Si:H) and for field dependent quantum efficiency in a-Si:H are presented. The optimization of phosphorus-doped a-Si:H carried out in four different discharge systems is described. Some details of the dc proximity and rf magnetron discharge systems are also provided. Preliminary mass spectroscopy studies of the rf magnetron discharge in both

#### **02 SOLAR ENERGY**

SiH4 and SiF4 are presented. Measurements of the surface photovoltage were used to estimate the distribution of surface states of phosphorus-doped and undoped a-Si:H. A detailed description of carrier generation, recombination, and transport in a-Si:H solar cells is given. Finally, some characteristics of Pd-Schottky-barrier cells are described for different processing

N80-32925# Grumman Aerospace Corp., Bethpage, N.Y. ELECTROCHEMICAL PHOTOVOLTAIC CELLS CdSe THIN FILM ELECTRODES Quarterly Progress Report, Jun. - Aug. 1979

M. A. Russak and C. Creter Sep. 1979 34 p refs (Contract EG-77-C-01-4042) (DSE-4042-T16; QPR-1) Avail: NTIS HC A03/MF A01

Conversion efficiencies in the range of 10% with electrochemical cells utilizing thin film electrodes were obtained. A CdSe/ aqueous sulfide polysulfide system was studied. Results of the initial CdSe deposition parameter study are given. The ratio of Se and Dc in the as deposited film has marked effect on the film's chemical, microstructural, optical, and electrical properties.

N80-32926# California Univ., Livermore. Lawrence Livermore Lab. Chemical Engineering Div.

SOLAR GASIFICATION OF CHARCOAL WOOD AND PAPER

R. W. Taylor, Rene Berjoan (CNRS, Font Romeu, France), and J. P. Coutures (CNRS, Font Romeu, France) 20 May 1980 15 p Presented at User's Assoc. Annual Meeting, Las Cruces, N. Mex., 15-17 Apr. 1980 Submitted for publication (Contract W-7405-eng-48)

(UCRL-84411; CONF-800481-1) NTIS HC A02/MF A01

Charcoal, wood and paper were gasified in a 2 kW solar furnace by injecting water directly on the hot fuel. In the case of charcoal, approximately 30% of the incident solar energy was stored as chemical energy and 55% of the injected water was consumed. Wood and paper gasification are explained by conventional pyrolysis followed by the gasification of the charcoal formed.

N80-32927# California Univ., Berkeley. Lawrence Berkeley Materials and Molecular Research Div.

RESEARCH ON Cu SUB x S/(Cd, Zn)S PHOTOVOLTAIC SOLAR ENERGY CONVERTERS Final Report, Mar. 1977 -Sep. 1979

B. L. Chin, T. M. Peterson, U. Dahmen, K. Seshan, L. E. Sindelar, and J. Washburn Mar. 1980 119 p refs (Contract W-7405-eng-48) (LBL-10791) Avail: NTIS HC A06/MF A01

The factors affecting the operation of CdS/Cu/sub x/S and

(Cd,Zn)S/Cu/sub x/S photovoltaic cells were studied. The approach was to systematically study the single crystal heterojunction so as to eliminate the complicating effects of grain boundaries. Single crystal CdS and (Cd,Zn)S thin films were deposited onto both GaAs and Ge substrates by a hot wall vacuum deposition technique. These grown films were studied using X-ray diffraction, SEM-EDAX, TEM and Hall Effect experiments. Information concerning the effects of varying processing parameters on the chemical and structural nature of the deposited films was obtained. Detailed TEM studies revealed the presence of different dislocation structures which affect the cell performance. The relationship between structural information and cell operation was studied. DOE

N80-32928# Argonne National Lab., III. SATELLITE POWER SYSTEMS (SPS) COST REVIEW J. H. Crowley and E. J. Ziegler May 1980 89 p refs (Contract W-31-109-eng-38)

(DOE/TIC-11190) Avail: NTIS HC A05/MF A01

Estimated costs for three selected SPS designs were determined. One SPS concept uses silicon solar cells with a concentration ratio of one; the second uses gallium arsenide solar cells with a concentration ratio of two; and the third (reference) design incorporates features of the first two. The systems within the SPS designs chosen include: rectenna construction: graphite fiber reinforced thermoplastic structures: solar cells, satellite electrical slip rings; satellite electrical systems. and ground rectenna electrical systems.

N80-32929# Solar Environmental Engineering Co., Inc., Fort SOLOCOST Service Center Collins, Colo.

**SOLAR INDEX GENERATION AND DELIVERY** 

Loren J. Lantz 1980 97 p refs (Contract DE-AC02-78ET-20090)

(DOE/ET-20090/3) Avail: NTIS HC A05/MF A01

Basically, the Solar Index represents the percentage of energy that solar would provide in order to heat an 80 gallon service hot water load for a given location and day. The Index is computed by utilizing SOLOCOST, a computer program, which also has applications to space heating, cooling, and heat pump systems and which supplies economic analyses for such solar energy systems. The Index is generated for approximately 68 geographic locations in the country on a daily basis. The definition of the Index, how the project came to be, what it is at the present time and a plan for the future are described.

N80-32934# Solarex Corp., Rockville, Md. INVESTIGATION OF THE IMPURITY TOLERANCE OF SEMICRYSTALLINE SILICON SOLAR CELLS SILICON **IMPACT PROGRAM** 

G. Storti, W. Regnault, S. Johnson, H. C. Lin (Maryland Univ.), and R. W. Armstrong (Maryland Univ.) 31 Mar. 1980 96 p Sponsored by Solar Energy Research Inst. (Contract DE-AC02-77CH-00178)

(DOE/CH-00178-T2; QTPR-2) Avail: NTIS HC A05/MF A01

Design modifications were made to incorporate thermocouples into the polysilicon casting furnace to allow for the constant monitoring of the temperature profile during the casting process. A source of metallurgical grade (MG) silicon was chosen and the material was prepared by grinding the large pieces into powder. The uniformity of the feedstock was ascertained by optical emission spectrograph analysis of three random samples of the feedstock. A total of sixteen casting runs were made this quarter: Union Carbide CMG graphite was found to be the most suitable crucible material. Solar cells were fabricated from the successful castings (five 100% SG, and two containing 1% and 5% MG silicon, respectively). The average efficiency from the first SG ingot was 10.4% AMO (in excess of 12% AM1). In general, solar cells fabricated from the top and bottom of the ingots exhibited better overall characteristics. The addition of MG silicon to the casting caused a large degradation in both light and dark I-V characteristics.

N80-32935# Sandia Labs., Albuquerque, N. Mex. US NATIONAL PHOTOVOLTAICS PROGRAM AND APPLI-CATIONS EXPERIMENTS IN THE INTERMEDIATE SEC-TOR

Miguel Rios, Jr. 1980 35 p refs (Contract ,DE-AC04-76DP-00789)

(SAND-80-0587C) Avail: NTIS HC A03/MF A01

The Department of Energy (DOE) commercial readiness goals for photovoltaics technology are summarized and the role of the national labs, research centers, and institutes in the strategy for achievement of these goals is outlined. Some examples of the flatplate and concentrator photovoltaics experiments that are under construction through the DOE Program Research and Development Announcements (PRDAs) are discussed. These experiments establish system feasibility and demonstrate the applicability of photovoltaics as an alternative energy source in the intermediate sector (industrial, commercial, and, agricultural). Installed system costs for the proposed PRDAs are given and concentrator technology requirements for achievement of DOE commercial readiness goals are presented. DOF

N80-32936# Sandia Labs., Albuquerque, N. Mex. GALLIUM ARSENIDE PHOTOVOLTAIC DENSE ARRAY FOR CONCENTRATOR APPLICATIONS

J. J. Wiczer, J. A. Cape, and J. S. Harris, Jr. 1980 16 p refs Presented at the Intern. Symp. of the SPIE, San Diego, Calif., 28 Jul. 1980 Prepared in cooperation with Rockwell International Corp., Thousand Oaks, Calif.

(Contract DE-AC04-76DP-00789) (SAND-80-1569C; CONF-800)

HC A02/MF A01

CONF-800719-6) Ava

vail: NTIS

An array of 256 densely packed gallium arsenide (GaAs) solar cells was designed, fabricated and tested to explore the feasibility of operating photovoltaic subsystems at solar central receiver facilities. The design goals, fabrication processes, and observed test results for such a photovoltaic array are reported.

DOE

# N80-32937# Sandia Labs., Albuquerque, N. Mex. SIMPLE ECONOMIC EVALUATION AND APPLICATIONS EXPERIMENTS FOR PHOTOVOLTAIC SYSTEMS FOR REMOTE SITES

Miguel Rios, Jr. 1980 47 p refs (Contract DE-AC04-76DP-00789)

(SAND-80-0749C) Avail: NTIS HC A03/MF A01

A simple evaluation of the cost effectiveness of photovoltaic systems is presented. The evaluation was based on a calculation of breakeven costs of photovoltaics (PV) arrays with the levelized costs of two alternative energy sources (1) extension of the utility grid and (2) diesel generators. A selected number of PV applications experiments that are in progress in remote areas of the US are summarized. These applications experiments range from a 23 watt insect survey trap to a 100 kW PV system for a national park complex. The PV systems for remote areas are not cost effective in remote small applications with commercially available technology.

N80-32938# Rockwell International Corp., Thousand Oaks, Calif. Electronics Research Center.

## GALLIUM ARSENIDE PHOTOVOLTAIC DENSE ARRAY FOR CONCENTRATOR APPLICATIONS

J. A. Cape, J. S. Harris, Jr., and J. J. Wiczer (Sandia Labs., Albuquerque, N. Mex.) 1980 14 p Presented at the Am. Sect. of the ISES Conf., Phoenix, Ariz., 2 Jun. 1980 (Contract DE-AC04-76DP-00789)

(SAND-79-2270C; CONF-800604-32) Avail: NTIS

HC A02/MF A01

The design, fabrication, and testing are discussed for a dense array consisting of 16 overlapped linear modules each containing 16 contiguous 1 cm by 1.25 cm GaAs concentrator cells in a row. The overlapping is done so that only active cell area is presented to the concentrated sunlight. The array presents a frontal area of 320 cu cm and is designed to yield a system output of approximately 230 volts at 25 to 25 amps at 1000 SUNs.

N80-32939# A/S International Solar Power Co. Ltd., Gentofte (Denmark)

## FEASIBILITY STUDY ON A SOLAR HOUSE HEATING SYSTEM WITH A LOW QUALITY THERMAL FLOW Final Report

A. Eggers-Lura 1980 237 p refs

(EUR-6696-EN) Avail: NTIS (US Sales Only) HC A11/MF A01: DOE Depository Libraries

A solar energy/heatpump house heating system with a low quality thermal flow, and of integration into prefabricated concrete element buildings were studied. Denmark's energy problem, its energy policy, and its housing and building industry are briefly described. A survey is made of existing buildings in Europe which use high density walls/roofs as solar collectors, and of research and development work being undertaken in EEC on concrete solar collectors. The component that comprise a solar heating system integrated into a prefabricated concrete building structure are described. Feasibility of a solar/heatpump heating system integrated into a prefabricated one family dwelling of the dense, low level type was studied. Descriptions of the building and its heating system are given. Heat balance calculations private economy and energy economy calculations of the house and its alternative heating system are presented, and finally recommendations are made as to future work. DOE

N80-32944# Chamberlain Mfg. Co., Waterloo, Iowa. Research and Development Div.

## THE 3X COMPOUND PARABOLIC CONCENTRATING (CPC) SOLAR ENERGY COLLECTOR Final Technical Report

Robert W. Ballheim 25 Apr. 1980 207 p refs (Contract DE-AC04-78CS-04239)

(DOE/CS-04239/T1: CMC-C8178-PR-017) Avail: NTIS HC A10/MF A01

A 3X compounds parabolic concentrating (CPC) collector was designed. The collector is a completely housed, 105.75 x 44.75 x 10.23 inch, 240 pound unit with six each evacuated receiver assemblies, a center manifold and a one piece glass cover. A truncated version of a CPC trough reflector system and the General Electric Company tubular evacuated receiver were integrated with a mass producible collector design suitable for operation at 250 to 450 F. The key criterion for optimization of the design was minimization of the cost per Btu collected annually at an operating temperature of 400 F. The reflector is a 4.1X design truncated to a total height of 8.0 inches with a resulting actual concentration ratio of 2.6 to 1. The manifold is an insulated area housing the fluid lines which connect the six receivers in series with inlet and outlet tubes extending from one side of the collector at the center. DOF

# N80-32945# SRI International Corp., Menlo Park, Calif. LINE-FOCUS SOLAR CENTRAL POWER SYSTEM, PHASE 1. SUBSYSTEM EXPERIMENT: RECEIVER HEAT TRANS-FER

Arthur J. Slemmons Apr. 1980 125 p refs (Contract EY-76-C-03-0115)

(DOE/ET-20550/1) Avail: NTIS HC A06/MF A01

Wind tunnel tests confirmed that heat losses due to natural convection are negligible in the line focus, solar powered receiver. Anomalies in the forced convection tests prevented definitive conclusions regarding the more important forced convection. Flow-visualization tests using a water table show much lower velocities inside the receiver cavity than outside, supporting the supposition that the forced heat transfer should be less than that from a standard exposed cylinder. Furthermore, the water table tests showed ways to decrease the low velocities in the cavity should this be desired. Further wind tunnel testing should be done to confirm estimates and to support advanced design. This testing can be done in standard wind tunnels since only the forced convection is of concern.

N80-32946# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

## THERMOGRAPHIC TECHNIQUES APPLIED TO SOLAR COLLECTOR SYSTEMS ANALYSIS

Anthony Eden Feb. 1980 8 p refs Presented at ASME Century 2 Emerging Energy Technol. Conf., San Francisco, 19-21 Aug. 1980

(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)

(SERI/TP-351-540; CONF-800804-20) Avail: NTIS HC A02/MF A01

The use of thermography to analyze large solar collector array systems under dynamic operating conditions is discussed. The research focused on thermographic techniques and equipment to determine temperature distributions, flow patterns, and air blockages in solar collectors. The results, covering many sites and types of collectors, illustrate the capabilities of infrared (IR) analysis as a qualitative analysis tool and operation and maintenance procedure when applied to large arrays. Thermographic analysis of most collector systems qualitatively showed relative temperature distributions that indicated balanced flow patterns. In three significant cases, blocked or broken collector arrays, which previously had gone undetected, were discovered. Using this analysis, validation studies of large computer codes could examine collector arrays for flow patterns or blockages that could cause disagreement between actual and predicted performance. DOF

N80-32947# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

#### SOLAR PONDS AND THEIR APPLICATIONS

T. S. Jayadev and M. Edesess Mar. 1980 12 p refs Presented

at the 7th Energy Technol. Conf. and Exposition, Washington, D.C., 25 Mar. 1980 (Contracts DE-AC02-77CH-00178; EG-77-C-01-4042)

(SERI/TP-733-617: CONF-800352-4) NTIS Avail: HC A02/MF A01

Solar ponds are probably the simplest and least expensive technology for conversion of solar energy to thermal energy. The solar pond is unique in its ability to act both as collector and as storage. The cost of a solar pond per unit area is considerably less than that of any active collector available today. The combination of their economic and technical factors make solar ponds attractive for district heating and industrial process heat applications. Solar ponds have the potential to displace significant quantities of fossil fuel in low-temperature heating applications in nonurban areas. DOF

N80-32952# Franklin Research Center, Philadelphia, Pa. SELF CONTROLLING, SELF PUMPING HEAT CIRCULATION SYSTEM STUDY Final Report, 1 Aug. 1977 - 31 Jul. 1978
G. P. Wachtell 31 Jul. 1978 153 p refs (Contracts DE-AC02-77CS-34484; EG-77-C-02-4484)

(COO-4484-07; FRC-C4772-2)

HC A08/MF A01

NTIS

Self pumping methods for transporting heat from roofmounted flat plate solar collectors to thermal energy storage at a lower evaluation are described and evaluated. Power cycles are feasible for sensible heat transport with air or water, and also in latent heat transport systems. Vapor bubble life for circulating water and latent heat transport with condensate return by the vapor stream are recommended for development as devices with no moving parts. Development of an injector for circulating liquid is also recommended, although higher collector temperatures or circulants that are more volatile than water would be needed. Some methods of delivering heat to the TES using photovoltaic power or small amounts of utility power were evaluated.

N80-32953# Florida Univ., Gainesville. Dept. of Materials Science and Engineering.

#### OXIDATION OF ELECTRODEPOSITED BLACK CHROME SELECTIVE SOLAR ABSORBER FILMS

P. H. Holloway, K. Shanker, R. B. Pettit (Sandia National Labs.), and R. R. Sowell (Sandia National Labs.) 1980 19 p refs Presented at the Intern. Conf. on Met. Coatings, San Diego, Calif., 21 Apr. 1980

(Contracts DE-AC04-76DP-00789; DE-FG02-79ER-10541) CONF-800439-11) (SAND-80-1045C; Avail:

HC A02/MF A01

NTIS

X-ray photoelectron and Auger electron spectroscopes were used to study the composition and oxidation of electrodeposited black chrome films. The outer layer of the film is Cr2O3 with the inner layer being a continuously changing mixture of Cr + Cr2O3. Initially, approximately 40 percent by volume of the film is combined as Cr2O3, and the volume percentage of Cr2O3 increases to greater than 60 percent after only 136 hours at 250 C. After approximately 3600 hours at 400 C, the volume percentage of Cr2O3 increased to as high as 80 percent. The thermal emittance decreased approximately linearly with increasing oxide content, while the solar absorptance remained constant until the percentage of Cr2O3 exceeded approximately 70 percent. Oxidation was slower when the Cr(+3) concentration in the plating bath was reduced from 16 g/l to 8 g/l, and when black chrome was deposited on stainless steel rather than sulfamate

N80-32954# Puerto Rico Office of Energy, Santurce. CONCENTRATING PHOTOVOLTAICS FOR THE TROPICS Final Report, 1 Jun. 1978 - 28 Feb. 1979

30 Jun. 1979 283 p refs (Contract ET-78-C-04-4270)

(DOE/CS-04270/1) Avail: NTIS HC A13/MF A01

The design and specifications of a photovoltaic concentrator total energy system are presented. The design will provide nearly half the electrical energy needs and most of the thermal energy needs (absorption chillers) of the Center for Energy and Environment Research, University of Puerto Rico, and the hot water needs of the Oncologic Hospital and Children's Hospital, Puerto Rico Medical Center. The system will utilize 34,190 sq. ft of 40X slat type concentrators with secondary CPC concentrators to provide 162 kWe. The combined photovoltaic/thermal collector system utilizes a 20,000 gal steel thermal storage tank, and two absorption refrigeration units which will produce a total of 149 tons of cooling. Detailed drawings and system fabrication and installation plans are included. Insolation data for the San Juan, Puerto Rico site are presented, and calculated system performance based on this data is presented.

N80-32959# Midwest Research Inst., Golden, Colo. Buildings Div

#### POTENTIAL DISPLACEMENT OF PETROLEUM IMPORTS BY SOLAR ENERGY TECHNOLOGIES

Peter DeLeon, Byron L. Jackson, Robert F. McNown (Colorado Univ., Boulder), and Gary J. Mahrenholz (Colorado Univ., Boulder) May 1980 59 p refs

(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042) (SERI/TR-352-504) Avail: NTIS HC A04/MF A01

The United States currently imports close to half of its petroleum requirements. The economic, social, and political costs of a foreign oil dependency are discussed. Development of alternative, domestic energy sources, such as solar energy technologies, which can displace foreign petroleum is discussed. It is estimated that by the year 2000, solar energy technologies can displace 3.6 quads of petroleum. This figure includes solar energy applications in utilities, industrial and agricultural process heat, and transportation. The estimate can be treated as a lower bound; if the United States were to achieve the proposed goal of 20 quads by 2000, the amount of displaced oil probably would be greater. Although all the displaced oil would not be imported, the reduction in imported petroleum would relieve many of the conditions that increase the present cost of foreign oil to the American consumer. DOE

N80-32961# Polytechnic Inst. of New York, Brooklyn. Solar Energy Applications Center.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT SOLAR HOT WATER INITIATIVE: CENTRALIZED COOR-DINATION OF TECHNICAL TASKS AND SYSTEM EVALUA-TION Final Report

Richard S. Thorsen, Donald F. Hunt, Wheeler K. Mueller, Anil V. Padhye, and Ellen P. Priolo Dec. 1979 414 p Sponsored in part by HUD, Washington, D.C. and N.Y. State Energy Research and Development Authority

(PB80-189244: POLY-M/AE-79-64: HUD-0001443) Avail: NTIS HC A18/MF A01 CSCL 13A

The installation of 10,867 approved solar hot water heating systems in 10 contiguous Northeastern and Middle Atlantic States and Florida by August 1978 is described. Specific problems, such as availability of standards and test laboratories, installation deficiencies, and warranty requirements, are listed as well as their solutions. GRA

N80-32962# Tata Energy Research Inst., Bombay (India). Documentation Centre.

SOLAR PASSIVE SYSTEMS FOR BUILDINGS

Mar. 1980 54 p refs

(PB80-187719) Avail: NTIS HC A04/MF A01 CSCL 13A

A survey is provided of what is known about the design of solar passive buildings. A systematic presentation is given of proven concepts with suitable illustrations. It is intended as a general guide for architects, designers and other building practitioners. Topics include the various concepts of solar passive heating and cooling, design factors such as location, climate, microclimate, form; building metabolism, thermal and visual comfort; location and form of illumination; and natural cooling via wind towers and cisterns.

N80-33465\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio. SYNCHRONOUS ENERGY TECHNOLOGY

Sep. 1980 144 p Symp. held in Cleveland, 29-30 Apr. 1980

(NASA-CP-2154; E-469) Avail: NTIS HC A07/MF A01 CSCL

The synchronous technology requirements for large space power systems are summarized. A variety of technology areas including photovoltaics, thermal management, and energy storage, and power management are addressed.

N80-33466\* # National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SYNCHRONOUS ENERGY TECHNOLOGY PROGRAM Robert C. Finke In its Synchronous Energy Technol. Sep. 1980

Avail: NTIS HC A07/MF A01 CSCL 10B

The power program in NASA and DOD are discussed with emphasis on the technology for future large space power systems. The structure of the synchronous energy technology program is described and the technologies required for future geosynchronous power stations are defined. The output of the program is to be a series of design data documents to provide design information and to transfer the technology to the involved community. R.C.T.

N80-33470\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

#### PHOTOVOLTAIC TECHNOLOGY DEVELOPMENT FOR SYNCHRONOUS ORBIT

Henry W. Brandhorst In its Synchronous Energy Technol. Sep. 1980 p 45-56 Avail: NTIS HC A07/MF A01 CSCL 10A

Accomplishments and expected benefits are summarized for the following efforts: (1) achieving silicon solar cell efficiency of 18% at 200 micron m to 250 micron m thickness; (2) reducing silicon cell radiation damage in geosynchronous orbit after 10 years to less than 15% (3) demonstrating coplanar back contact 50 micron m thick silicon solar cells with efficiency of 14%: (4) demonstrating the feasibility of a radiation tolerant GaAs concentrator cell; (5) achieving 30% efficient photo conversion in the laboratory; (6) defining candidate concepts for 50% efficient electromagnetic conversion; and (7) demonstrating the technology for protecting arrays capable of > 300W/kg after 10 years in geosynchronous orbit.

N80-33471\*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

LARGE SOLAR ARRAYS

William L. Crabtree In NASA. Lewis Space Flight Center Synchronous Energy Technol. Sep. 1980 p 57-68

Avail: NTIS HC A07/MF A01 CSCL 10A

A spectrophotovoltaic converter, a thermophotovoltaic converter, a cassegrainian concentrator, a large silicon cell blanket, and a high flux approach are among the concepts being investigated as part of the multihundred kW solar array program for reducing the cost of photovoltaic energy in space. These concepts involve a range of technology risks, the highest risk being represented by the thermophotovoltaics and spectrophotovoltaics approaches which involve manipulation to of the incoming spectrum to enhance system efficiency. The planar array (solar blanket) has no technology risk and a moderate payback. The primary characteristics, components, and technology concerns of each of these concepts are summarized. An orbital power platform mission in the late 1980's is being used to allow a coherent technology advancement program in order to achieve a ten year life with maintenance at a capital recurring cost of \$30/watt based on 1978 dollars. A.R.H.

#### N80-33854 Polytechnic Inst. of New York. OPTIMUM SYSTEMS DESIGN WITH RANDOM INPUT AND OUTPUT' APPLIED TO SOLAR WATER Ph.D. Thesis

Layek Lamel Abdel-Malek 1980 157 p Avail: Univ. Microfilms Order No. 8019381

Solar water heating systems are evaluated. Models were developed to estimate the percentage of energy supplied from the Sun to a household. Since solar water heating systems have random input and output queueing theory, birth and death processes were the major tools in developing the models of evaluation. Microeconomics methods help in determining the optimum size of the solar water heating system design parameters, i.e., the water tank volume and the collector area. Dissert. Abstr.

#### N80-33858\*# First National Bank of Clarksdale, Miss. SOLAR HEATING SYSTEM AT QUITMAN COUNTY BANK, MARKS, MISSISSIPPI Final Report

Jun. 1980 119 p Sponsored by NASA (Contract EM-78-F-01-5199)

(NASA-CR-161549) Avail: NTIS HC A06/MF A01 CSCL 10B

Information on the Solar Energy Heating System installed in a single story wood frame, cedar exterior, sloped roof building is presented. The system has on-site temperature and power measurements readouts. The 468 square feet of Solaron air flat plate collectors provide for 2,000 square feet of space heating, an estimated 60 percent of the heating load. Solar heated air is distributed to the 235 cubic foot rock storage box or to the load (space heating) by a 960 cubic feet per minute air handler unit. A 7.5 ton Carrier air-to-air heat pump with 15 kilowatts of electric booster strips serve as a back-up (auxiliary) to the solar system. Motorized dampers control the direction of airflow and back draft dampers prevent thermal siphoning of conditioned

#### N80-33864\*# Wormser Scientific Corp., Stamford, Conn. INSTALLATION, OPERATION, AND MAINTENANCE FOR THE PYRAMIDAL OPTICS SOLAR SYSTEM INSTALLED AT YACHT COVER, COLUMBIA, SOUTH CAROLINA

Sep. 1980 105 p Sponsored in part by DOE (Contract NAS8-32250)

(NASA-CR-161203) Avail: NTIS HC A06/MF A01 CSCL

Information concerning the installation, operation, and maintenance of the pyramidal Solar System for space heating and domestic hot water is presented. Principles of operation, sequence of installation, and procedures for the operation and maintenance of each subsystem making up the solar system are presented. Troubleshooting charts and maintenance schedules are presented. T.M.

#### N80-33865\*# Wormser Scientific Corp., Stamford, Conn. DESIGN DATA BROCHURE FOR A PYRAMIDAL OPTICAL SOLAR SYSTEM

Sep. 1980 36 p. Sponsored in part by DOE (Contract NAS8-32250)

(NASA-CR-161202) Avail: NTIS HC A03/MF A01 10A

A pyramidal optics solar system for solar heating and domestic hot water is described. The system is made up of the collecting, storage, and distribution subsystems. System description, available accessories, installation arrangements, physical data, piping and wiring diagrams, and guide specifications are included. J.M.S.

#### N80-33866\*# Elcam, Inc., Santa Barbara, Calif. INSTALLATION PACKAGE FOR A SUNSPOT CASCADE SOLAR WATER HEATING SYSTEM

Sep. 1980 51 p Sponsored in part by DOE (Contract NAS8-32245)

(NASA-CR-161562) Avail: NTIS HC A04/MF A01

Solar water heating systems installed at Tempe, Arizona and San Diego, California are described. The systems consist of the following: collector, collector-tank water loop, solar tank, conventional tank, and controls. General guidelines which may be utilized in development of detailed installation plans and specifications are provided along with instruction on operation. maintenance, and installation of solar hot water systems. J.M.S.

N80-33867\*# Elcam, Inc., Santa Barbara, Calif. DESIGN PACKAGE FOR SOLAR DOMESTIC HOT WATER SYSTEM

Sep. 1980 149 p refs Sponsored in part by DOE (Contract NAS8-32245)

(NASA-CR-161558) Avail: NTIS HC A07/MF A01 CSCL

The initial design of a solar domestic hot water system is considered. The system performance specification and detailed design drawings are included. The hot water systems consist of the following subsystems: collector, storage, control, transport, auxiliary energy, and government-furnished site data acquisition. The two systems are installed at Tempe, Arizona, and San Diego, California.

N80-33873# European Space Agency, Paris (France).
PHOTOVOLTAIC GENERATORS IN SPACE

W. R. Burke, ed. Jun. 1980 266 p refs Presented at 2nd European Symp., Heidelberg, 15-17 Apr. 1980: sponsored by DGLR e.V.

(ESA-SP-147) Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

Design and verification of solar blankets, ultrathin cell module technology, solar array diodes, space qualified GaAs solar cells, and cell covers are discussed. Other topics include radiation effects on solar cells, computer aided design techniques applied to solar arrays, tests of cells, arrays, and structures.

N80-33880# Societe Nationale Industrielle Aerospatiale, Cannes (France).

#### SPOT SOLAR ARRAY

Gerard Barkats, Michel Calvy, and Michel Cathala In ESA Photovoltaic Generators in Space Jun. 1980 p 55-63

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

The electrical and structural designs are presented for a double deployment direction flexible fold-out solar array. The required power in orbit is 1 kW at the end of two years. Flexibility for different missions and the constraints of the Ariane shroud are design considerations. A stowage box was designed to accommodate all proposed configurations of array. An air bag system protects the folded blankets. Solar panels are built up of standard subpanels. Arrays up to 11.7 m in span are possible. Mass and power output data are given for various size arrays.

Author (ESA)

N80-33882# AEG-Telefunken, Wedel (West Germany). Space and New Technologies Div.

POTENTIAL USE OF TERRESTRIAL PHOTOVOLTAICS FOR FUTURE SPACE SOLAR ARRAYS

H. Bebermeier and J. Rath  $\it I\dot{n}$  ESA Photovoltaic Generators in Space Jun. 1980 p 73-77

Avail: NTIS HC A12/MF A01: ESA, Paris FF 80

The status and development goals of terrestrial and space solar cells are compared. Present terrestrial solar array production lines make use of many space qualified technologies and processes and can be utilized, either with terrestrial or with space solar cells, for the manufacture of large area space solar arrays. It is shown that single crystal silicon solar cells can be used at potentially lower cost when a moderate mass increase of the array is acceptable. A space telescope solar array, scaled up to 25 kW would require a 6% increase in blanket size and a 32% mass increase.

Author (ESA)

N80-33884# AEG-Telefunken, Heilbronn (West Germany). Semiconductor Div.

ASPECTS OF LARGE AREA AND THIN SILICON SOLAR CELL TECHNOLOGIES

K.-D. Rasch and K. Roy *In* ESA Photovoltaic Generators in Space Jun. 1980 p 95-99 refs Sponsored by Bundesministerium fuer Forschung und Technologie

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

Computer and experimental data are given for thin high efficiency cells utilizing back surface reflector (BSR) and back surface field (BSF) technologies. It is shown that there is no

advantage in employing BSF technology for cells thicker than 100 micrometers. The BSR technology is useful for all thicknesses. Cells thinner than 100 micrometers have higher end of life power than thicker ones when BSR and BSF are used. For cells thinner than 100 micrometers, a redesign of cover glasses, interconnectors, and solar panel construction is necessary to profit from cell weight advantages.

Author (ESA)

N80-33885# Spectrolab, Inc., Sylmar, Calif.
THIN, HIGH EFFICIENCY SILICON SOLAR CELLS
R. Opjorden, M. Gillanders, and J. Fodor In ESA Photovoltaic
Generators in Space Jun. 1980 p 101-104 ref

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

Data are presented for cell processing yields, beginning-oflife electrical outputs, electron, neutron and proton irradiation effects, and thermal alpha measurements. Panel fabrication techniques for thin cells are also discussed. A viable process sequence was established for the cells using high purity, low resistivity, gallium doped float zone silicon as the starting material. They exhibited enhanced radiation hardness and showed stability under proton irradiation, regardless of thickness. Author (ESA)

N80-33886# Hughes Aircraft Co., El Segundo, Calif. Space and Communications Group.

QUALIFICATION TEST RESULTS OF THE PRODUCTION HIGH EFFICIENCY K6-3/4 AND K7 SILICON SOLAR CELLS

Leland J. Goldhammer In ESA Photovoltaic Generators in Space Jun. 1980 p 105-115 refs

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

The K6-3/4 and K7 solar cells were fully qualified and characterized for use in a space environment. These solar cells are a 10 Ohm-cm, shallow diffused, N/P solar cell with a back surface field, and an aluminum back surface reflector. The front surface of the K6-3/4 solar cell has a dual layer antireflective coating and the front surface of the cover glass is frosted (etched). The front surface of the K7 solar cell is sculptured (etched) and has a single layer antireflective coating; the front surface of the cover glass is polished. Both solar cell types are solder coated. The tests performed and a description of test conditions are lised.

N80-33888\*# Hughes Research Labs., Malibu, Calif.
DEVELOPMENT OF SPACE-QUALIFIED GaAs SOLAR
CELLS

R. C. Knechtli, G. S. Kamath, J. Ewan, and R. Y. Loo. *In ESA* Photovoltaic Generators in Space. Jun. 1980. p. 121-126. refs Sponsored in part by NASA and USAF.

Avail: NTIS HC A12/MF A01: ESA. Paris FF 80 CSCL 10A Cells 2 cm x 2 cm were produced having an efficiency of 16% at 100 C and 12% at 200 C. They were superior to silicon cells under 1 MeV electron bombardment up to fluences in excess of 10 to the 15th power electron per sq cm, and to protons with an energy in excess of 1 MeV. The possibility of producing cells in quantity using a graphite wafer holder is mentioned.

Author (ESA)

N80-33889\*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio.

RADIATION DAMAGE IN HIGH VOLTAGE SILICON SOLAR CELLS

Irving Weinberg, Henry W. Brandhorst, Clifford K. Swartz, and Victor G. Weizer In ESA Photovoltaic Generators in Space Jun. 1980 p 129-134 refs

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80 CSCL 10A High open circuit voltage cell designs based on 0.1 Ohm cm p-type silicon were irradiated with 1 MeV electrons and their performance determined to fluences as high as 10 to the 15th power per sq cm. Of the three cell designs, radiation induced degradation was greatest in the high low emitter (HLE) cell. The diffused and ion implanted cells degraded approximately equally but less than the HLE cell. Degradation was greatest in

an HLE cell exposed to X-rays before electron irradiation. The cell regions controlling both short circuit current and open circuit voltage degradation were defined in all three cell types. An increase in front surface recombination velocity accompanied time dependent degradation of an HLE cell after X-irradiation. It was speculated that this was indirectly due to a decrease in positive charge at the silicon oxide interface. Modifications aimed at reducing radiation induced degradation are proposed for all three cell types.

Author (ESA)

# N80-33890# AEG-Telefunken, Heilbronn (West Germany). COMPARISON OF SILICON SOLAR CELL CHARACTERISTICS AT OPERATING TEMPERATURE AFTER ELECTRON IRRADIATION

R. Schilling, K.-D. Rasch, and H. Bebermeier In ESA Photovoltaic Generators in Space Jun. 1980 p 135-139 refs Sponsored by Bundesministerium fuer Forschung und Technologie

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

The degradation characteristics during electron irradiation of different solar cell structures were determined. High efficiency cells (HEC), back surface field (BSF), back surface reflector (BSR), nonreflective and back surface field reflector (BSFR) cells were fabricated from a float zone and from a crucible grown boron doped crystal. The solar cell data including the solar absorptance and the temperature dependence of cell parameters were determined after fabrication and after 1 MeV electron irradiation of fluences in the range of 3 x 10 to the 13th power per sq cm to 2 x 10 to the 15th power per sq cm. The difference cell structures can be directly compared at standard test conditions and at operating conditions excluding influences of material variations. The effects of BSR, which controls the operating temperature, do not decrease after electron irradiation. Solar cells with applied back surface reflector HEC-BSR and HEC-BSFR deliver the highest power performance at operating conditions.

Author (ESA)

## N80-33893# Applied Solar Energy Corp., City of Industry, Calif. IMPACT OF TERRESTRIAL SOLAR CELL DEVELOPMENT ON SPACE APPLICATIONS

P. A. Iles *In* ESA Photovoltaic Generators in Space Jun 1980 p 155-160

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

Projected space missions are outlined and the cell requirements by mission type mentioned. The techniques used to produce low cost terrestrial use cells are examined for their applicability to space needs, including silicon cell fabrication, barrier formation, contact applications, coatings, and encapsulation. The most likely area for the transfer of terrestrial cell technology is in low Earth orbit missions, based on the use of the shuttle craft.

Author (ESA)

N80-33898# European Space Technology Center, Noordwijk (Netherlands).

EFFICIENT THERMAL CYCLING OF SOLAR PANELS IN SOLAR SIMULATION FACILITIES WITH A MULTI-PANEL TEST RIG

P. W. Brinkmann and J. Reimann (Industrieanlagen Betriebsgesellschaft m.b.H.) *In* ESA Photovoltaic Generators in Space Jun. 1980 p 195-202 refs

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

It is shown that efficient thermal cycling tests under vacuum can be performed at reduced costs to cover the requirements for qualifications and acceptance testing of solar panels. A suitable test rig was developed which allows simultaneous testing of up to 3 solar panels with a dimension of 1.3 m x 1.7 m each. The tests can be performed in an existing solar simulation facility with a beam diameter of only 2.4 m. This means that a close simulation of orbital conditions can be achieved, including severe exlipse conditions with rapid temperature changes. Chamber dimensions, descriptions of suspension devices, and other data needed by potential users are given.

Author (ESA)

N80-33900# Optical Coating Lab., Inc., Santa Rosa, Calif.
AN EVALUATION OF SPECTRALLY SELECTIVE REFLECTORS (COLD MIRROR MEMBRANES) FOR USE WITH CONCENTRATOR SOLAR ARRAYS

William T. Beauchamp, James D. Rancourt, and Dan R. Lott (Lockheed Missiles and Space Co., Sunnyvale, Calif.) In ESA Photovoltaic Generators in Space Jun. 1980 p 211-216 refs

Avail: NTIS HC A12/MF A01; ESA Paris FF 80

Spectrally selective reflector (SSR) coatings on lightweight transparent membranes were evaluated as a method of concentrating light for achieving increased power without suffering severe temperature losses on solar arrays. Analysis and laboratory tests indicate that SSR concentrators are more effective than opaque reflectors with both silicon and GaAs cells for increasing array output. Large area SSR membranes can be produced in roll to roll coaters at cost that will be competitive with other reflecting membranes.

Author (ESA)

N80-33907# Air Force Inst. of Tech., Wright-Patterson AFB, Obio

## COMPREHENSIVE PLANNING FOR PASSIVE SOLAR ARCHITECTURAL RETROFIT M.S. Thesis

Stanley H. Scofield May 1980 329 p refs

(AD-A088660; AFIT-CT-80-19T) Avail:

HC A15/MF A01 CSCL 13/1

This thesis proposes a new method for developing Passive Solar Architectural Retrofit Concepts to be used in Air Force Project Booklets. This method can be used for 'in-house' design projects, A E design projects, and major projects administered by Army or Navy Engineering. This thesis has three parts: A series of 35 'patterns' to be used by the Architectural Programmer and user. The recommendations contained in each 'pattern' are specific enough for the programmer and user to identify the decisions they need to make early in the programming process, and yet the recommendations are not overly restrictive to the designer. A sample Passive Solar Architectural Retrofit Program using selected 'patterns' from part one of this thesis, A sample Conceptual Design using the Architectural Program of part two of this thesis is described.

N80-33911# McDonnell-Douglas Astronautics Co., Huntington Beach, Calif.

## CLEANING AGENTS AND TECHNIQUES FOR CONCENTRATING SOLAR COLLECTORS

M. B. Sheratte May 1980 91 p refs (Contract DE-AC04-76DP-00789)

(SAND-79-7052) Avail: NTIS HC A05/MF A01

Tests were conducted to determine the nature of the soil which is irreversibly deposited on solar collectors during environmental exposure. Methods of removing this soil were investigated. The mechanism of attachment of the soil to the surface was determined as a potential aid to cleaning agent formulation. Reflector specimens were exposed at sites in Shenandoah, GA, Albuquerque, NM, and Daggett, CA. Three types of reflector surfaces were studied: second surface silvered glass, aluminized FEK 244 film on glass substrate, and RTV 670 on aluminum. Cleaning procedures were evaluated by microscopic examination of the solid surfaces before and after cleaning and by measurement of specular reflectance. The potential effectiveness of environmental cleaning agents, much as rain, frost and snow, is discussed.

N80-33953# Natal Univ., Pietermaritzburg (South Africa). Dept. of Mechanical Engineering.

THE USE OF SOLAR ENERGY FOR COOKING

N. Tully and A. G. Lawrence In CSIR. Intern. Conf. on Air Pollution, Vol. 3 25 Oct. 1979 30 p refs

Avail: NTIS HC A16/MF A01

The background of the fuel and ecological crisis is reviewed with respect to the availability of solar energy. Particular attention is given to the possible widespread adoption of solar cooking among the rural African population. Various types of solar cookers are discussed with emphasis on the open concentrator employing

#### 02 SOLAR ENERGY

the spherical cast iron cooking pot. The performance of this design under variable conditions of misalignment, solar insolation, wind velocity, etc. is given. Successful initial field trials are described.

### 03 HYDROGEN

Includes hydrogen production, storage, and distribution.

A80-43842 Hydrogen in metals - Outstanding properties and examples for utilization. II (Wasserstoff in Metallen - Herausragende Eigenschaften und Beispiele für deren Nutzung. II). H. Wenzl (Kernforschungsanlage Jülich GmbH, Institut für Festkörperforschung, Jülich, West Germany). Metall, vol. 34, July 1980, p. 647-653. In German.

The discussion of hydrogen in metals covers the production and storage of high purity hydrogen, activation and optimalization of hydrogen storage alloys, and metal hydrides as hydrogen storage in automobiles. Further, the use of metal hydrides as heat storage, heat motors with metal hydrides, and hydrides in fusion reactors are examined.

M.E.P.

A80-44598 Conversion of carbohydrate into hydrogen fuel by a photocatalytic process. T. Kawai and T. Sakata (Institute for Molecular Science, Okazaki, Japan). *Nature*, vol. 286, July 31, 1980, p. 474-476. 12 refs.

A photocatalytic process for the conversion of carbohydrates into hydrogen fuel is presented. The method involves the irradiation of sugar, starch or cellulose in the presence of water and a RuO2/TiO2/Pt catalyst, which has been found to lead to the generation of CO2 and H2 at efficiencies 100 times larger than those obtained with TiO2 alone, with no detectable amounts of other products. The reaction mechanism can be explained in terms of an electrochemical microcell, in which electron-hole pairs generated in TiO2 cause redox reactions at the surface. The process may thus be used in the conversion of solar energy stored in the form of carbohydrates by green plant photosynthesis into useful hydrogen fuels.

A.L.W.

A80-45060 Hydrogen storage in a beryllium substituted TiFe compound. G. Bruzzone, G. Costa, M. Ferretti, and G. L. Olcese (Genova, Università, Genoa, Italy). *International Journal of Hydrogen Energy*, vol. 5, no. 3, 1980, p. 317-322. 8 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A80-45298 Hydrogen and oxygen from water. III - Evaluation of a hybrid process. R. B. Diver and E. A. Fletcher (Minnesota, University, Minneapolis, Minn.). *Energy* (UK), vol. 5, July 1980, p. 597-607. 9 refs. Contract No. ER-78-02-4737.

The paper presents a hybrid process which produces simultaneously mechanical power and hydrogen from water by the use of solar energy. Solar energy in this model is collected at very high and at near ambient temperatures. This model uses heat rejected from the high-temperature heat exchanger in a Rankine or other conventional heat engine to operate the pumps and to produce mechanical power; the heat pump is eliminated and flat solar collectors are used to vaporize the water. It was found that reactor-separators will require membranes with Knudsen numbers of 25; the heat exchanger specifications, the heat engine, and pumps where hydrogen is compressed to 50 atm for long-range pipeline transport are discussed. It was concluded that the results given here for a device which operated at 2800 K with an upstream pressure of 0.2 atm, and which feasible.

A80-46271 # Man-made molecular assemblies for energy conversion from light into chemical potentials. T. Matsuo, T. Nagamura (Kyushu University, Fukuoka, Japan), K. Itoh, and T. Nishijima. Kyushu University, Faculty of Engineering, Memoirs, vol. 40, Mar. 1980, p. 25-36. 12 refs.

An attempt has been made to achieve essential parts of the processes involved in photosynthesis by the use of polypyridine complexes of ruthenium (II) together with man-made molecular assemblies such as surfactant micelles, lipid membranes, and polymer

chains. In the case of micellar systems, cationic surfactants afforded the most effective reaction site for the charge separation of the photoproduced ion pairs, so that the photo-activated ruthenium complex on the micellar surface could be used as very good redox catalysts. An electron transporting polymer was prepared and proved to afford an efficient multielectron conversion catalyst for photon-chemical hydrogen production in aqueous system, when it was used in combination with platinum colloid. Man-made molecular assemblies are thus concluded to be very useful for the construction of energy conversion system from light into chemical potentials.

(Author)

A80-47665 Heavy water as a valuable by-product of electrolytic hydrogen. M. Hammerli (Atomic Energy of Canada, Ltd., Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada). International Journal of Hydrogen Energy, vol. 5, no. 4, 1980, p. 409-422. 21 refs.

A Combined Electrolysis Catalytic Exchange-Heavy Water Process (CECE-HWP) is being developed at Chalk River with the ultimate aim of producing by-product heavy water from electrolytic hydrogen streams although other earlier potential applications are also discussed. The gross heavy water dollar credit per GJ, based on the higher heating value of hydrogen, has been calculated as a function of the important variables: recovery, feed concentration, and price. Based on preliminary data and cost estimates, the net heavy water dollar credit has been estimated to be at least comparable to the by-product oxygen credit. The potential for by-product heavy water production from hydrogen in general, and from electrolytic hydrogen in particular, in Canada, the U.S.A., and the Western World is discussed in relation to Canada's present primary heavy water production capacity. (Author)

A80-47666 A system consideration of alternative hydrogen storage facilities for estimation of storage costs. C. Carpetis (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Technische Physik, Stuttgart, West Germany). International Journal of Hydrogen Energy, vol. 5, no. 4, 1980, p. 423-437. 5 refs.

An economic evaluation of alternative hydrogen storage methods is presented. The cost estimating technique is formulated to clarify the importance and influence of the relevant parameters and to base the input on specific data of the modules of the storage facility. A consistent application of this technique attempts to define the useful range of application for the alternative hydrogen storage methods.

(Author)

A80-47667 Utilization of solar radiation for water photolysis. E. Broda (Wien, Universität, Vienna, Austria). *International Journal of Hydrogen Energy*, vol. 5, no. 4, 1980, p. 453, 454. 5 refs.

The objections of Melvin against the photolysis of water as a future source of technical hydrogen are not valid. Sufficient hydrogen to cover the energy requirements of very large numbers of people can, with reasonable assumptions, be expected from relatively small areas: in a hot arid country 1000 megawatts from 40 sq km. H2 need not be more expensive than crude oil at the present price, per unit fuel value, if membranes, plus auxiliary equipment, etc., can be provided at 32 dollars/sq m. It is concluded that the photochemical option for the utilization of solar energy shows great promise in the long run. However, most of the fundamental research still needs to be done. (Author)

A80-48290 # A thermodynamic analysis of a metal hydride heat pump. H. Abelson and J. S. Horowitz (Argonne National Laboratory, Argonne, III.) In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 936-945. 6 refs. Research supported by the U.S. Department of Energy.

A detailed thermodynamic analysis of a metal hydride heat pump utilizing the heat of adsorption/desorption of hydrogen on a

#### 03 HYDROGEN

metal alloy surface is presented. The analysis models an entire cycle of the heat pump and includes a computer simulation of the regenerative heat exchange process. The proposed heat pump features a unique tubular design with 200 individual tubes and external regeneration loops which reduce the performance losses inherent in thermal cycling. A prediction of the coefficient of the pump performance is obtained. The pump can be used with a variety of heat sources, such as industrial waste heat, solar energy, and even a fossil fuel.

V.L.

A80-48403 # The fusion-synfuel tie producing hydrogen with the Tandem Mirror Reactor. R. W. Werner (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1662-1667. 9 refs. Contract No. W-7405-eng-48.

The paper reports a study to determine how the fusion program, and particularly the future Tandem Mirror Reactor, can benefit and support the production of synthetic, portable fuels that are vital to the economy of the U.S. In the case under study the reactor is used as a 1200 K heat source driving a thermochemical cycle whose output product is hydrogen. Principal focus is placed on the conceptual design of the reactors main energy source, the blanket module. The module under study is a LiNa cauldron design which is a binary, liquid metal pool boiler using lithium as the neutron moderator and sodium as the heat transfer fluid with latent heat as the main energy transport mechanism. (Author)

A80-48404 # Interfacing the Tandem Mirror Reactor to the sulfur-iodine process for hydrogen production. T. R. Galloway (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1668-1674. 23 refs. Contract No. W-7405-eng-48.

The paper reports progress to date on coupling the Tandem Mirror Reactor (TMR) to thermochemical cycles for hydrogen production. The sulfur iodine cycle and the blanket concept based on a pool boiler of a molten mixture of lithium and sodium are used as examples. Linking the blanket to the H2SO4 vaporization units and SO3 decomposition reactor with either sodium or helium is examined, and the engineering and safety problems associated with these choices are discussed. This H2SO4 step uses about 90% of the TMR heat and is best close-coupled to the nuclear island. The rest of the process is driven by steam and does not require close-coupling. (Author)

A80-48405 # Materials considerations for the coupling of thermochemical hydrogen cycles to tandem mirror reactors. O. H. Krikorian (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1675-1679. 12 refs. Contract No. W-7405-eng-48.

Candidate materials are discussed and initial choices made for the critical elements in a liquid Li-Na Cauldron Tandem Mirror blanket and the General Atomic Sulfur-Iodine Cycle for thermochemical hydrogen production. V and Ti alloys provide low neutron activation, good radiation damage resistance, and good chemical compatibility for the Cauldron design. Aluminide coated In-800H and siliconized SiC are materials choices for heat exchanger components in the thermochemical cycle interface. (Author)

A80-48406 # Scoping study of a tandem-mirror fusion reactor coupled to a thermochemical hydrogen synfuel plant. F. L. Ribe, G. L. Woodruff (Washington, University, Seattle, Wash.), and D. L. Rowe. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference,

Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1680-1685. 10 refs. Research sponsored by the U.S. Department of Energy.

A80-48412 # The MARK-13 process for hydrogen production. D. van Velzen and H. Langenkamp (Commission of the European Communities, Joint Research Centre, Ispra, Italy). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1716-1720. 7 refs.

The MARK-13 process for hydrogen production by the thermochemical decomposition of water is evaluated on the basis of data for a bench-scale plant which has been in operation since May 1978. The nominal hydrogen production rate of the plant is 100 l/h. The plant, constructed mainly of commercial glass and quartz equipment connected with PTFE tubing, operates at atmospheric pressure. Operation data indicate that thermochemical water decomposition is a valid alternative for hydrogen production. Specified reactant concentrations and conversions can be reached and stably maintained over long periods, and until now, no by-products have been detected in any reactor section.

A80-48413 # Development status of the General Electric solid polymer electrolyte water electrolysis technology. L. J. Nuttall (General Electric Co., Wilmington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1721-1724.

A80-48414 # High-temperature water electrolysis for hydrogen production. R. M. Bowman, B. J. Jody, and K. F. Blurton (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. { New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1725-1730. U.S. Department of Energy Contract No. 31-109-38-4449.

A80-48415 # Catalytic combustion of hydrogen in model appliances. J. B. Pangborn (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1731-1736. 5 refs.

Several catalytic-burner configurations have been evaluated in order to test the feasibility and practicality of appliances using the catalytic combustion of hydrogen in air or at the surface of a specially catalyzed material. The model appliances presented are self-starting without preheating, efficient in delivery of energy, nonpolluting, and very low in NOx output. Aluminum and anodized aluminum catalyzed through a chloroplatinic acid application procedure proved to be practical materials of construction. Thermal efficiencies exceeding 80% (based on the high heating value of hydrogen) were noted for water heating, and efficiencies exceeding 95% were noted for space heating with humidification.

A80-48416 # Hydrogen production from the solar based LASL cadmium cycle. C. F. V. Mason, M. G. Bowman, and R. G. Behrens (California, University, Los Alamos, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1737-1740. 9 refs. Research sponsored by the U.S. Department of Energy.

A thermochemical H2 cycle is presented where the high temperature step can be powered by a solar heat source. The cycle consists of three reactions: the thermal decompositions of CdO and CdCO3 and the oxidation of Cd using water and CO2 to form CdCO3 and H2. Experimental data is presented which indicates that CdO(g) is less stable than previously thought. Kinetic studies of the H2 producing reaction show both Pd and NH4Cl to be good catalysts. NH4Cl, although introducing more possibilities for side reactions, appears to be the better catalyst. Drying studies on CdCO3 show that water retention problems are minimal. (Author)

A80-48449 # High-temperature thermochemical water splitting cycle fusion reactor design considerations. E. T. Cheng, C. P. C. Wong, K. H. McCorkle, Jr., P. W. Trester, and K. R. Schultz (General Atomic Co., San Diego, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1943-1950. 19 refs. Research supported by the General Atomic Co., Northeast Utilities Service Co., and Public Service Electric and Gas Co.

The design considerations were explored for the adaptation of the high-temperature General Atomic sulfur-iodine thermochemical water splitting cycle to a fusion reactor heat source. This high-temperature cycle modification was found to have a good heat line match to the fusion heat source with an attractive possibility of process simplification compared to the reference HTGR-adapted cycle. The cost improvement due to the modification is potentially 14-30% lower than in the HTGR cycle. In designing such a synfuel reactor, the tritium breeding and handling concerns, materials compatibility, heat removal and radioactivity contamination of the hydrogen product and chemical processes are among the potential problem areas investigated. Viable design approaches were identified for each problem area and constitute the basis for a comprehensive conceptual synfuel fusion reactor design study. (Author)

A80-48450 # Present and future status of thermochemical cycles applied to fusion energy sources. L. A. Booth, K. E. Cox, R. A. Krakowski, and J. H. Pendergrass (California, University, Los Alamos, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference; Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1951-1958. 11 refs.

This paper reviews the status of current research on thermochemical hydrogen production cycles and identifies the needs for advanced cycles and materials research. The Los Alamos Scientific Laboratory (LASL) bismuth sulfate thermochemical cycle is characterized, and fusion reactor blanket concepts for both inertial and magnetic confinement schemes are presented as thermal energy sources for process heat applications. (Author)

A80-48451 # High-temperature fusion blanket for a synthetic fuel plant. L. C. Steinhauer, M. H. Shirazian, and C. Bruzzone (Mathematical Sciences Northwest, Inc., Bellevue, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1959-1963. Contract No. ET-78-C06-1095.

A fusion reactor to drive a synthetic fuel production plant is described. The particular synfuel process involves dissociation of CO2 at high-temperature and subsequent rapid cooling in an unsteady wave reactor to 'freeze' the CO constituent which later produces H2 (the synthetic fuel) and CO2 when reacted with steam. This technique requires very high temperatures, 2400 K or more, in the blanket outlet stream to achieve efficient synfuel conversion and therefore demands an unusual blanket, designed to withstand both high temperature and a chemically reactive environment. A promising design for such a blanket is described which is characterized by low-pressure coolant, a ceramic 'brick oven' matrix and structural support by a thin, relatively cool, metal jacket. (Author)

A80-48458 # A comparison of capital cost estimates and process efficiencies for hydrogen production by thermochemical cycles and water electrolysis. K. E. Cox (California, University, Los Alamos, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 1993-1999. 12 refs.

A survey of capital cost estimates and process efficiencies for two different technologies for producing hydrogen from water has been completed. Thermochemical cycles show costs ranging from \$600-1100/kW H2 while advanced methods of water electrolysis were estimated in the range of \$700-1100/kW H2. In general, efficiencies for thermochemical cycles were higher at 40-55%, than for water electrolysis systems at 30-40%. (Author)

A80-48459 # Process economics and the second law in thermochemical hydrogen production - The effect of heat transfer. J. E. Funk and J. K. Prueitt (Kentucky, University, Lexington, Ky.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 2000-2003. 9 refs.

The cost to produce hydrogen in a thermochemical water decomposition process varies inversely with overall process thermal efficiency and directly with the capital cost of the process equipment. The process design, as described by flowsheets and mass and energy balances, determines both efficiency and equipment costs. The efficiency is determined by the thermodynamic irreversibilities which result when the process is designed as it will actually be built and operated. In this paper the relationship among the irreversibilities, efficiency, capital costs, and production costs is presented. Quantitative results for the effect of heat transfer on efficiency and production cost are developed. A production cost thermal efficiency diagram is shown for the case in which all process equipment has the same irreversibility/cost relationship as heat exchangers. (Author)

A80-48460 # Recent progress on the sulfur cycle hybrid hydrogen production process. W. A. Summers, R. L. Ammon and G. H. Parker (Westinghouse Electric Corp., Advanced Energy Systems Div., Pittsburgh, Pa.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 2008-2014.

Highlights of recent technological progress, design and operational studies are reviewed for the sulfur cycle hydrogen production process. For hydrogen plants driven by solar energy, operational considerations have been taken into account when making plant configuration and performance estimates. The design of a high temperature sulfuric acid decomposition reactor has been prepared for a solar driven plant. This design uses an intermediate working fluid (e.g., air) between the solar receiver and decomposition reactor. From a series of materials test programs, several metals and silicon based materials have demonstrated good corrosion resistance to the acid environment. As a result, attractive candidates have been identified for structural materials for the high temperature acid handling components. Substantial progress has been made in the development of electrodes for the sulfur dioxide electrolyzer. An operating cell exhibited a stable low voltage during a one week (Author) endurance test.

A80-48461 # Off-peak power for hydrogen production. K. E. Johnson and A. Verma (Saskatchewan Power Corp., Research and Development Centre, Regina, Canada). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 2015-2018.

Electric utilities are in the interesting situation that it may be cheaper for them to produce hydrogen electrolytically using off-peak power than to make it directly by the steam reforming reaction. Several load versus time profiles are discussed and the Saskatchewan situation is elaborated upon. The topping power need not be off-peak (cheapest) but its price together with the efficiency of the electrolytic units are the critical factors. The argument is extended to other electrolytic processes, electrolysis and fuel cells. (Author)

A80-48503 \* # A hybrid water-splitting cycle using copper sulfate and mixed copper oxides. J. D. Schreiber, R. J. Remick, S. E. Foh, and M. M. Mazumder (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2285-2288. 10 refs. Research sponsored by the Gas Research Institute and NASA.

The Institute of Gas Technology has derived and developed a hybrid thermochemical water-splitting cycle based on mixed copper oxides and copper sulfate. Similar to other metal oxide-metal sulfate cycles that use a metal oxide to 'concentrate' electrolytically produced sulfuric acid, this cycle offers the advantage of producing oxygen (to be vented) and sulfur dioxide (to be recycled) in separate steps, thereby eliminating the need of another step to separate these gases. The conceptual process flow-sheet efficiency of the cycle promises to exceed 50%. It has been completely demonstrated in the laboratory with recycled materials. Research in the electrochemical oxidation of sulfur dioxide to produce sulfuric acid and hydrogen performed at IGT indicates that the cell performance goals of 200 mA/sq cm at 0.5 V will be attainable using relatively inexpensive electrode materials. (Author)

A80-49704 Prospects for hydrogen aircraft. G. D. Brewer (Lockheed-California Col., Burbank, Calif.). Society of Automotive Engineers, International Air Transportation Meeting, Cincinnati, Ohio, May 20-22, 1980, Paper 800756. 14 p. 17 refs.

Liquid methane, synthetic Jet A, and liquid hydrogen fuels are compared. Liquid hydrogen is shown to be an attractive candidate based on theory and analysis. Representative configurations of LH2-fueled subsonic and supersonic aircraft are presented. V.T.

A80-50247 Biophotolytic H2 production using alginate-immobilized chloroplasts, enzymes and synthetic catalysts. P. E. Gisby and D. O. Hall (King's College, London, England). *Nature*, vol. 287, Sept. 18, 1980, p. 251-253. 16 refs. Research supported by the Commission of the European Communities.

Hydrogen can be produced by illumination of an aqueous mixture of chloroplasts and hydrogenase, in the presence of an electron carrier. This system may have potential for development of a solar converter to produce hydrogen from water if it can be stabilized or constructed as a completely synthetic system. The immobilization of the chloroplasts, or membrane analogues, would make possible a one-stage reactor with all the components in one chamber, or a two-stage reactor if the electron carrier was passed to another chamber to react with an immobilized hydrogen-producing catalyst. However, techniques for immobilizing enzymes tend to yield immobilized chloroplasts that are not very active, and other methods must be used. This paper describes the immobilization of chloroplasts using calcium alginate gels on reinforcing grids of nylon and stainless steel. Chloroplasts thus immobilized are fully active and can be used to produce hydrogen gas. Strengthened films of this sort could provide a good, solid, rigid matrix for a solar converter.

(Author)

A80-50511 The thermodynamics of aqueous water electrolysis. R. L. LeRoy, C. T. Bowen (Electrolyser Inc., Etobicoke, Ontario; Noranda Research Centre, Pointe Claire, Quebec, Canada), and D. J. LeRoy (Science Research Council, Ottawa, Canada).

Electrochemical Society, Journal, vol. 127, Sept. 1980, p. 1954-1962, 21 refs.

Precise definitions are given of three thermodynamic parameters which characterize the water-electrolysis reaction: the enthalpic voltage, the higher-heating-value voltage, and the thermoneutral voltage. Expressions are derived for these parameters and for the reversible potential, as functions of temperature between 25 deg and 250 deg C, and of pressure between 1 and 100 arm. Heat losses due to radiation, convection, and conduction are also considered, and a thermal-balance voltage is defined; representative values are calculated. Electrical-energy efficiency is related to the characteristic parameters, and thermodynamic limitations on its value are discussed. (Author)

A80-50512 Models for the photoelectrolytic decomposition of water at semiconducting oxide anodes. J. M. Kowalski, K. H. Johnson, and H. L. Tuller (MIT, Cambridge, Mass.). (Electrochemical Society, Meeting, Boston, Mass., May 6-11, 1979.) Electrochemical Society, Journal, vol. 127, Sept. 1980, p. 1969-1973. Contracts No. N00014-78-C-0366; No. N00014-75-C-0970.

Surface states at semiconducting TiO2/electrolyte interfaces are believed to play an important role in charge transfer and thereby the efficiency of photoelectrochemical processes at such interfaces. Theoretical calculations were therefore performed using the SCF-X alpha-SW method to determine the position and character of surface states at various characteristic interfaces. At the TiO2/water interface, antibonding surface states were found which when occupied would explain the experimentally observed dissociation of water into hydroxyl groups at n-type semiconducting TiO2 surfaces. Similarly, antibonding surface states were found at the TiO2/OH- interface which when occupied would tend to destabilize the OH bond. A likely mechanism for the dissociation of water and decomposition of certain photoanodes in photo-electrochemical cells based on the above results is presented. The effects of surface reconstruction at heavily reduced TiO2 surfaces on the validity of the calculations are also discussed.

A80-50623 Hydrogen storage in magnesium powder. B. Vigeholm, J. Kjoller, and B. Larsen (Riso National Laboratory, Roskilde, Denmark). Powder Metallurgy International, vol. 12, Aug. 1980, p. 136, 137. 8 refs.

A high pressure facility allowed the study of the reaction of hydrogen with magnesium powder. Immediate reaction leading to MgH2 took place. It was found that no pretreatment of the powder is needed, that surface oxidation has no harmful effect, that the reaction starts at 250 C and is completed at 4 MPa after 15 min.

(Author)

A80-51460 Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water. V. D. Dang and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). Energy Conversion and Management, vol. 20, no. 2, 1980, p. 85-101. 40 refs. Contract No. EY-76-C-02-0016.

Current studies of hydrogen production from water by thermochemical-electrochemical hybrid cycles and electrolysis are being done with particular attention to their application to the use of fusion energy. Eight hybrid cycles are evaluated on the basis of the following criteria: (1) thermodynamics, (2) experimental performance, (3) process design, (4) applicability of fusion reactors, and (5) possibility of commercialization in about five years. Current commercial technologies are presented for low temperature electrolysis of water; research and development efforts on the advanced alkaline water electrolyzer and the solid polymer electrolyzer are discussed; and the possibility of water electrolysis by advanced power cycles using fusion reactor energy is examined. (Author)

A80-51691 Visible light response of polycrystalline TiO2 electrodes. Y. Matsumoto, J. Kurimoto, Y. Amagasaki, and E. Sato

(Utsunomiya University, Utsunomiya, Japan). Electrochemical Society, Journal, vol. 127, Oct. 1980, p. 2148-2152. 34 refs.

The photocurrent response to visible light of Co-doped polycrystalline TiO2 electrodes is investigated. Monochromatic light of various wavelengths from a 500 W xenon lamp was used to irradiate undoped TiO2 electrodes and TiO2 electrodes coated with a Co(NO3)2 solution which were exposed to a pre-electrolyzed H2SO4 solution, and current-potential curves and photoresponses were monitored. Visible light photoresponses are obtained for both undoped polycrystalline TiO2 electrodes heated at temperatures above 700 C and Co-doped TiO2 electrodes prepared at 400-550 C, with the greater photoresponse in the visible provided by the doped electrode. Results thus indicate that the Co-doped polycrystalline electrode would be suitable for use as photoanode in the photoelectrolysis of water by solar energy, although improvements are necessary to obtain a large photocurrent. A.L.W.

A80-53569 A study on utilizing solar energy for hydrogen production. M. C. Chuang (Westinghouse Research Laboratories, Pittsburgh, Pa.). (American Institute of Chemical Engineers, National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 5-8, 1979.) AIChE Symposium Series, vol. 75, no. 189, 1979, p. 273-281. 8 refs.

Two types of solar concentrators were studied to investigate the potential to utilize solar energy for hydrogen production by using the Westinghouse Sulfur Water Decomposition system. From thermal analysis, it shows that the concentrator of paraboloid of revolution with evacuated receiver tube has greater potential than that of the cylindrical parabolic concentrator to collect adequately the solar energy for hydrogen production. (Author)

N80-28865\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SOLAR/HYDROGEN SYSTEMS ASSESSMENT. VOLUME 1: SOLAR/HYDROGEN SYSTEMS FOR THE. 1985 - 2000 TIME FRAME Final Report

R. W. Foster (Escher: Foster Tech. Associates, Inc.), R. R. Tison (Escher: Foster Tech. Associates, Inc.), W. J. D. Escher (Escher: Foster Tech. Associates, Inc.), and J. A. Hanson 2 Jun. 1980 149 p refs 2 Vol.

(Contracts NAS7-100; JPL-955492) (NASA-CR-163392; JPL-9950-379) Avail:

HC A07/MF A01 CSCL 10B

Opportunities for commercialization of systems capable of producing hydrogen from solar energy were studied. The hydrogen product costs that might be achieved by the four selected candidate systems was compared with the pricing structure and practices of the commodity gas market. Subsequently, product cost and market price match was noted to exist in the small user sector of the hydrogen marketplace. Barriers to and historical time lags in, commercialization of new technologies are reviewed. Recommendations for development and demonstration programs designed to accelerate the commercialization of the candidate systems are presented.

N80-29519# National Technical Information Service, Springfield,

HYDROGEN PRODUCTION. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1978 - May 1980
Diane M. Cavagnaro May 1980 208 p Supersedes NTIS/PS-

79/0541

(PB80-810476; NTIS/PS-79/0541) HC \$30.00/MF \$30.00 CSCL 21D

The cited reports include studies on the manufacturing of hydrogen by electrolysis, coal gasification and other techniques. They cover both experimental research and production on the industrial scale. Although most of the reports are on production methods, economic studies are also included. This updated bibliography contians 200 abstracts, 56 of which are new entiries to the previous edition.

N80-30550# Oak Ridge National Lab., Tenn. Technology Div. SIMULTANEOUS PHOTOPRODUCTION OF HYDROGEN AND OXYGEN BY PHOTOSYNTHESIS

Elias Greenbaum 1979 21 p refs Presented at 2d Symp. on Biotechnol. in Energy Production and Conserv., Gatlinburg, Tenn., 2-5 Oct. 1979

(Contract W-7405-eng-26)

(CONF-791072-32) Avail: NTIS HC A02/MF A01

Results suggest that the photosynthetic production of hydrogen and oxygen represents an intriguing way to capture and convert solar energy into stored chemical free energy. It is particularly noteworthy that all three of the only known potential, direct photosynthetic watersplitting systems - blue-green algae, green algae, and the chloroplast-ferredoxin-hydrogenase system, have now been shown to photoproduce molecular hydrogen and oxygen simultaneously for prolonged periods of time.

N80-30561# National Technical Information Service, Springfield,

HYDROGEN STORAGE: HYDROGEN AS A HYDRIDE. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1974 - May 1980

Diane M. Cavagnaro Jun. 1980 142 p Supersedes NTIS/PS-79/ 0582; NTIS/PS-78/0547 Updates NTIS/PS-75/379

NTIS/PS-79/0582; (PB80-811Ó94; NTIS/PS-78/0547) Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

The bibliography covers hydrogen storage as a hydride. Topics include the chemical and physical properties of the hydride, and how useful it may be for hydrogen storage. Also considered is the conversion of hydrogen to a hydride and the conversion back to hydrogen. This updated bibliography contains 135 abstracts, 14 of which are new entries to the previous

# N80-30756# Miami Univ., Coral Gables, Fla. HYDROGEN ENGINE PERFORMANCE ANALYSIS PROJECT Annual Report

Robert R. Adt, Jr., Michael R. Swain, and John M. Pappas Jan. 1980 469 p refs Prepared in cooperation with Hawthorne Research and Testing, Inc., Coral Gables, Fla. (Contract EC-77-C-03-1212)

(SAN-1212-T1; AR-2) Avail: NTIS HC A20/MF A01

Baseline data for throttled and unthrottled, carburetted and timed hydrogen induction, IVC hydrogen-fueled engine configurations, with and without exhaust gas recirculation and water injection, were obtained. These data, along with descriptions of the test engine and its components, the test apparatus, experimental techniques, experiments performed and the results obtained, are given. Analyses of other hydrogen-engine project data are also presented and compared with the results of the present effort. The unthrottled engine vis-a-vis the throttled engine is found, in general, to exhibit higher brake thermal efficiency. The unthrottled engine also yields lower No sub x emissions. which were found to be a strong function of fuel-air equivalence ratio.

N80-31271# Aerospace Corp., El Segundo, Calif. Energy Conservation Directorate.

STUDY OF HYDROGEN-POWERED VERSUS BATTERY-POWERED AUTOMOBILES

J. J. Donnelly, Jr. (Escher Technology Associates), W. J. D. Escher, W. C. Greayer, and R. J. Nichols May 1979 79 p refs (Contract EM-78-C-03-2184)

(ATR-79(7759)-1-Vol-1) Avail: NTIS HC A05/MF A01

Potential vehicle characteristics were identified for two candidate automobile propulsion systems. The first vehicle system employs a gaseous, hydrogen-fueled, internal combustion engine and either a liquid or metal hydride energy storage system. The second vehicle system employs an electronically controlled, electric motor power-train and a battery energy storage system. Tasks performed included in the technical and economic assessment of the state of the art and future alternatives in hydrogen production and delivery, the hydrogen vehicle assment, the battery-electric vehicle assessment, and the comparison of the principal vehicle alternative in 1985, 1990, and 2000. The comparison included weight, size, cost, energy, and design range

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relationships and the implications on expenditure of all major energy sources. Results are presented, and conclusions are drawn. Comments are made on the future roles of hydrogen and electricity in automobile propulsion.

N80-31624\*# Air Products and Chemicals, Inc., Allentown,

# A STUDY OF INDUSTRIAL HYDROGEN AND SYNGAS SUPPLY SYSTEMS Final Report

W. J. Amos, J. Solomon, and K. F. Eliezer Oct. 1979 159 p Prepared for JPL

(Contracts NAS7-100; JPL-955421)

(NASA-CR-163523) Avail: NTIS HC A08/MF A01

The potential and incentives required for supplying hydrogen and syngas feedstocks to the U.S. chemical industry from coal gasification systems were evaluated. Future hydrogen and syngas demand for chemical manufacture was estimated by geographic area and projected economics for hydrogen and syngas manufacture was estimated with geographic area of manufacture and plant size as parameters. Natural gas, oil and coal feedstocks were considered. Problem areas presently affecting the commercial feasibility of coal gasification discussed include the impact of potential process improvements, factors involved in financing coal gasification plants, regulatory barriers affecting coal gasification, coal mining/transportation, air quality regulations, and competitive feedstock pricing barriers. The potential for making coal gasification the least costly H2 and syngas supply option. Options to stimulate coal gasification system development are discussed. A.R.H.

N80-31650# Solar Turbines International, San Diego, Calif. Applied Sciences Div.

AUTOMOTIVE STORAGE OF HYDROGEN USING MODI-FIED MAGNESIUM HYDRIDES Final Report, Mar. 1976 -Mar. 1978

D. A. Rohy, J. F. Nachman, A. N. Hammer, and T. E. Duffy 1979 82 p refs

(Contract EY-76-C-03-1167)

(SAN-1167-1) Avail: NTIS HC A05/MF A01

Due to the relative stability of MgH2, modifications of the MgMH/sub x/ (M = metal ion) were made to decrease the dissociation temperature while retaining high hydrogen capacity. This parameter is crucial since vehicle exhaust will supply the thermal energy to dissociate the hydride in an automobile. Hydride dissociation temperature (T/sub D/) should be 200 C to ensure uninterrupted fuel flow at all driving and idle conditions. Alloys comprised of Mg. Cu and Ni came closest to meeting the dissociation temperature goal. Dissociation temperature. hydrogen capacity and material cost are reported for each alloy tested in this program. DOE

#### N80-31651# General Atomic Co., San Diego, Calif. HYDROGEN PRODUCTION BY THE GA SULFUR-IODINE **PROCESS**

G. E. Besenbruch, K. H. McCorkle, J. H. Norman, D. R. OKeefe, J. R. Schuster, P. W. Trester, and M. Yoshimoto (Idemitsu Kosan Co., Ltd., Tokyo) May 1980 17 p Presented at the 3d World Hydrogen Energy Conf., Tokyo, 23 Jun. 1980 (Contract DE-AC02-80ET-26225; Proj. 3260)

Avail:

NTIS

CONF-800616-6-Rev) (GA-A-15777-Rev:

HC A02/MF A01

The progress of the overall total development effort of the General Atomic (GA) sulfur-iodine thermochemical water splitting cycle over the last two years is summarized. The major accomplishments were significant improvements in the chemistry of the process; development, review, and revision of an engineering flow sheet, resulting in a thermal process efficiency of 47%; screening, identification, and testing of potential materials-ofconstruction for the corrosive process fluids; small-scale demonstration of the cycle in a closed loop under recycle conditions; installation of bench-scale equipment and demonstration of parts of the processing in this system; and development of a conceptual, preliminary flowsheet for the GA sulfur-iodine cycle driven by solar energy. Thermochemical water splitting by

the sulfur-iodine cycle is a feasible process. Thermal efficiencies in the range of 50% are achievable.

N80-31927# California Univ., Berkeley. Sanitary Engineering Research Lab.

SOLAR ENERGY CONVERSION THROUGH BIOPHOTOLY-SIS Annual Report, 1 Apr. 1978 - 31 Mar. 1979

J. R. Benemann, M. A. Murray, P. C. Hallenbeck, K. Miyamoto, A. G. Olafsen, D. J. Esteva, and L. V. Kochian 1 May 1979 236 p refs

(Contract EY-76-S-03-0034)

(SAN-0034-239-1-T2; AR-3) Avail: NTIS HC A11/MF A01 The state-of-the-art of biophotolysis was reviewed and a bioengineering analysis carried out. The conclusions were that practical biophotolysis systems are feasible; however, they will require, in most cases, relatively long-term research and development. The biophotolysis system developed, utilizing heterocystous blue-green algae, was demonstrated both indoors and outdoors with a model converter system using the heterocystous blue-green alga Anabaena cylindrica. Maximal light energy conversion efficiencies were 2.5 percent indoors and about 0.2 percent outdoors, averaged for periods of about two weeks. Achievement of such rates required optimization of N2 supply and culture density. A small amount of N2 in the argon gas phase used to sparge the cultures was beneficial to the stability of a long-term hydrogen-production activity. A relatively small amount of the hydrogen produced by these cultures can be ascribed to the activity of the reversible hydrogenase which was studied by nitrogenase inactivation through poisoning with DOE tungstate.

#### N80-32553# Brookhaven National Lab., Upton, N. Y. HYDROGEN PRODUCTION FROM REMOTE POWER SITES

A. Mezzina, G. Grimes (DOE), R. Reeves (DOE), and R. Wiley (New York State Energy Research and Development Authority) Feb. 1980 10 p refs Presented at the Energy Sources Technol. Conf. and Exhibition, New Orleans, 3-7 Feb. 1980

(Contract EY-76-C-02-0016)

(BNL-27457: CONF-800204-9) HC A02/MF A01

NTIS

The basic concept for adopting small existing dams to hydrogen production entails the energy conversion steps: hydropower to shaft power via a hydraulic turbine; shaft power to electrical power via a generator; and electrical power to hydrogen (and oxygen) via a water electrolyzer. The resource availability is discussed. The concept implementation in Potsdam, New York is mentioned, DOF

N80-32554# Oak Ridge National Lab., Tenn. Technology Div.

MODELING AND EVALUATION OF DESIGNS FOR SOLID HYDROGEN STORAGE BEDS

P. W. Fisher and J. S. Watson 1980 11 p refs Presented at the 3d World Hydrogen Energy Conf., Tokyo, 23-26 Jun 1980

(Contract W-7405-eng-26)

(CONF-800616-8) Avail: NTIS HC A02/MF A01-

Mathematical models were developed to predict the performance of metal hydride beds used for hydrogen storage. The relative importance of heat transfer, mass transfer, chemical kinetics, and equilibrium were evaluated through comparison of the models with experimental data supplied by Brookhaven National Laboratory for a cylindrical bed containing FeTi alloy. An equilibrium model containing no empirical parameters produced bed pressure and temperature which showed good agreement with experimental data. This model was used to evaluate two proposed designs for solid hydrogen storage beds in which (1) FeTi alloy was contained in tubes that were externally cooled, and (2) FeTi alloy was contained in a bed that were penetrated by cooling tubes. The model predicts that heat transfer surface area is utilized most effectively with the second cooling configuraN80-32559# Brookhaven National Lab., Upton, N. Y. FUSION REACTORS FOR HYDROGEN PRODUCTION VIA ELECTROLYSIS

J. A. Fillo, J. R. Powell, and M. Steinberg 1979 7 p refs Presented at the 2d Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10-13 Dec. 1979 (Contract DE-AC02-76CH-00016) (BNL-27782; CONF-791204-37) Avail: NTIS

HC A02/MF A01

The decreasing availability of fossil fuels emphasizes the need to develop systems which will produce synthetic fuel to substitute for and supplement the natural supply. An important first step in the synthesis of liquid and gaseous fuels is the production of hydrogen. Thermonuclear fusion offers an inexhaustible source of energy for the production of hydrogen from water. Depending on design, electric generation efficiencies of approximately 40 to 60% and hydrogen production efficiencies by high temperature electrolysis of approximately 50 to 70% and projected for fusion reactors using high temperature blankets.

N80-32854\*# EIC, Inc., Newton, Mass.
HYDROGEN PRODUCTION BY PHOTOELECTROLYTIC
DECOMPOSITION OF H2O USING SOLAR ENERGY Final
Report, 1 Dec. 1975 - 30 Nov. 1979

R. D. Rauh, S. A. Alkaitis, J. M. Buzby, and R. Schiff Aug. 1980 66 p. refs

(Contracts NAS7-100; JPL-955271)

(NASA-CR-163586; JPL-9950-406) Avail

HC A04/MF A01 CSCL 10A

Photoelectrochemical systems for the efficient decomposition of water are discussed. Semiconducting d band oxides which would yield the combination of stability, low electron affinity, and moderate band gap essential for an efficient photoanode are sought. The materials PdO and Fe-xRhxO3 appear most likely. Oxygen evolution yields may also be improved by mediation of high energy oxidizing agents, such as CO3(-). Examination of several p type semiconductors as photocathodes revealed remarkable stability for p-GaAs, and also indicated p-CdTe as a stable H2 photoelectrode. Several potentially economical schemes for photoelectrochemical decomposition of water were examined, including photoelectrochemical diodes and two stage, four photon processes.

N80-32922# Miami Univ., Coral Gables, Fla. Clean Energy Research Inst.

ASSESSMENT OF HYDROGEN COMPRESSOR TECHNOLOGY FOR ENERGY STORAGE AND TRANSMISSION SYSTEMS Final Report

Laxman G. Phadke, T. Nejat Veziroglu, Richard W. Foster, and William J. D. Escher Jan. 1979 192 p refs Prepared in cooperation with Escher Technology Associates, St. Johns, Mich.

(Contract EC-77-S-05-5598)

(ORO-5598-T1) Avail: NTIS HC A09/MF A01

An initial assessment of hydrogen compressor technology for prospective energy systems applications is documented. Hydrogen, and hydrogen/natural gas blends, are generally related to the existing state of the art in natural compressors. Visits to natural gas transmission and storage facilities are reported on from the compressor applications standpoint. Present applications of hydrogen compressors, as reported by both manufacturers and users are summarized. Theoretical fluid dynamic and thermodynamic analysis of these fuel gases in compressors is provided. The implications of materials problems considered relevant to compressors are briefly discussed. Some general observations and recommendations are presented.

N80-33206# Brookhaven National Lab., Upton, N. Y. FUSION: AN ENERGY SOURCE FOR SYNTHETIC FUELS J. A. Fillo, J. Powell, and M. Steinberg 1980 9 p refs Presented at the AIAA Intern. Meeting and Tech. Display, Global Tech. 2000, Baltimore, 6-8 May, 1980 (Contract DE-AC02-76CH-00016) (BNL-27891; CONF-800590-1) Avail: NTIS

HC A02/MF A01

An important first step in the synthesis of liquid and gaseous fuels is the production of hydrogen. Thermonuclear fusion offers an inexhaustible source of energy for the production of hydrogen from water. Depending on design, electric generation efficiencies of approximately 40 to 60 percent and hydrogen production efficiencies by high temperature electrolysis of approximately 50 to 70 percent are projected for fusion reactors using high temperature blankets. Fusion/coal symbiotic systems appear economically promising for the first generation of commercial fusion synfuels plants. Coal production requirements and the environmental effects of large scale coal usage would be greatly reduced by a fusion/coal system.

N80-33607# National Technical Information Service, Springfield, Va

HYDROGEN USE AS A FUEL CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Jun. 1980 Audrey S. Hundemann Jul. 1980 228 p. Supersedes

NTIS/PS-79/0779 (PB80-813090;

90: NTIS/PS-79/0779)

Avail: NTIS

HC \$30.00/MF \$30.00 CSCL 21D

Federally funded research studies pertaining to the technical feasibility of using hydrogen as a fuel for vehicular transportation, electric power generation, and both subsonic and supersonic aircraft are discussed. Excluded are studies on hydrogen production and storage. These topics are covered in other bibliographies. This updated bibliography contains 206 citations, 20 of which are new entries to the previous edition.

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# FUELS AND OTHER SOURCES OF ENERGY

Includes fossil fuels, nuclear fuels, geothermal and ocean thermal energy, tidal energy, and wind energy.

A80-44846 Processing of coal, oil sand and heavy oil in situ by electric and magnetic fields. S. T. Fisher (F. T. Fisher's Sons, Ltd., Montreal, Canada). Canadian Electrical Engineering Journal, vol. 5, July 1980, p. 3, 4.

Improvements to a previously proposed (Fisher, 1979) means for the underground processing of coal, oil sand and heavy oil using eddy currents induced by an alternating magnetic field are presented. Consideration is given to the injection into the fuel layer by pressure from the surface of a hot, saturated high-conductivity aqueous electrolyte solution, which would allow induction heating to depend entirely on low-frequency eddy currents, and to the use of an outer tube of copper welded to an inner tube of steel for the tunnel and shaft casings and electrical conductors of the underground eddy-current heating installation. The physical and operational parameters of the proposed modifications are given, and it is shown that these improvements would increase the performance margin of the eddy-current heating method over the proposed dielectric heating method for oil shale and oil sand deposits.

A.L.W.

A80-45267 Coal gasification in fluidized bed combustion: Status and developments - Future perspectives (Kohlevergasung im Flugstrom: Stand und Entwicklungen - Zukünftige Perspektiven). H. Staege (Krupp-Koppers GmbH, Essen, West Germany). Energiewirtschaftliche Tagesfragen, vol. 30, July 1980, p. 512-515. In German.

The state of the art of fluidized bed combustion is surveyed. Attention is given to the steps in the process such as preparation of the coal, gasification of the coal dust, waste heat recycling, cooling, and removing of particulates, and treatment of the recirculating water. Also discussed are removal of sulfur from the gas, developments of the principle such as the Shell-Kopper process, Saarberg-Otto process, and the Texaco-process.

M.E.P.

A80-45322 One-dimensional model for pulverized coal combustion and gasification. P. J. Smith and L. D. Smoot (Brigham Young University, Provo, Utah). Combustion Science and Technology, vol. 23, no. 1-2, 1980, p. 17-31. 37 refs. Research supported by the Electric Power Research Institute; Contract No. EF-77-S-01-2666.

A one-dimensional model has been developed for pulverized coal-combustors and gasifiers. The model describes the response of a coal particle system to its thermal, chemical and physical environment. Moisture vaporization, coal devolatilization, heterogeneous char oxidation, gas particle interchange, radiation, gas phase oxidation, primary and secondary stream mixing, and heat losses are considered. A predictor-corrector solution technique was used to solve the ordinary non-linear differential equations. Several combustor and gasifier predictions are shown. The model predictions are compared with experimental data. The effects of particle size and distribution are shown to be particularly important. Significant rate controlling processes include initial particle heat-up and char surface reaction.

(Author)

A80-45512 Status of coal hydrogenation in Europe (Stand der Kohlehydrierung in Europa). I. Romey (Bergbau-Forschung GmbH, Essen, West Germany). Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie, vol. 33, July 1980, p. 314-321. In German.

The technical feasibility of large scale coal liquefaction units is supported by the knowledge gained in the construction and operation of smaller plants. It is noted that economic and political issues are the main factors regarding the construction of large scale plants. Attention is given to availability of oil and the assumed supply noting that while coal liquefaction alone cannot solve all future energy problems, liquid hydrocarbons from coal can contribute towards alleviation of the risks. Finally, consideration is given to a study of possible sites and the problems involved in the construction of a commercial plant, that has been initiated by the government of Nordrhein-Westfalen in Germany.

A80-45513 Status of coal hydrogenation outside Europe (Stand der Kohlehydrierung ausserhalb von Europa). E. Wolowski and O. Funk (Ruhrkohle Öl und Gas GmbH, Boltrop, West Germany). Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie, vol. 33, July 1980, p. 321-326. In German. Contract No. EF-77-C-01-2468.

It is noted that in recent years the development of coal liquefaction processes in the USA has been supported by governmental funding because of the expected worldwide shortage of oil products. The technical feasibility and the economy of the processes will have to be proven by operation of pilot-, demonstration-, and production plants. Attention is given to the processes of Gulf (SRC II), Exxon (EDS) and HRI (H-Coal), and the status of the projects and economy of the processes is described.

M.E.P.

A80-46170 Electromagnetic methods in applied geophysics. K. Vozoff (Macquarie University, Sidney, Australia: California, University, Berkeley, Calif.). (International Association of Geomagnetism and Aeronomy, Workshop on Electromagnetic Induction in the Earth and Moon, 4th, Mumau, West Germany, Sept. 7-13, 1978.) Geophysical Surveys, vol. 4, Sept. 1980, p. 9-29. 65 refs.

Review of promising new research developments dealing with electromagnetic methods in applied geophysics. Slow, steady progress of numerical modeling is seen in traditional low-frequency CW technology. Cryogenic coil systems are viewed as the major development in this area. In the newer area of transient applications, the most impressive results are coming from the use of seismic processing with earth-penetrating radar and the rapid development of transient electromagnetic equipment, theory, and experience.

T.M.

A80-46197 Feasibility of a peat biogasification process. M. G. Buivid, D. L. Wise (Dynatech R/D Co., Cambridge, Mass.), A. M. Rader (Minnesota Gas Co., Minneapolis, Minn.), P. L. McCarty, and W. F. Owen (Stanford University, Palo Alto, Calif.). Resource Recovery and Conservation, vol. 5, July 1980, p. 117-138. 71 refs. Research supported by the Minnesota Gas Co.

The feasibility of a two-stage biogasification process for the conversion of peat reserves, the energy content of which in the United States is greater than that of uranium, shale oil or petroleum and natural gas combined, into pipeline-quality methane is investigated. Samples of wet-harvested reed-sedge peat were pretreated in alkaline and nonalkaline conditions in the presence and absence of oxidation in order to determine the most favorable conditions for the conversion of cellulosic and lignaceous fractions to water-soluble, fermentable compounds, and the resulting products were subjected to anaerobic fermentation to methane. Conversion efficiencies obtained reveal that up to 26% of the initial heat content of peat was converted to methane when alkaline heat pretreatment was employed. Analysis of the process parameters by a computer model to determine equipment sizes, mass and energy balances and costs indicates that for a 79,200 GJ/day plant the total capital requirement would be \$323,000,000, annual operating costs would be \$44,000,000 and average SNG cost would be \$3.16/GJ, assuming a 90% stream factor with a delivered peat slurry costing \$0.0033/kg.

A.L.W.

A80-46325 # The U.S. coal gasification program - Progress and projects. C. L. Miller (U.S. Department of Energy, Gasification Process Section, Washington, D.C.). Mechanical Engineering, vol. 102, Aug. 1980, p. 34-40.

Progress in the development of coal gasification processes in the United States is reviewed. The evolution of coal gasifier design and processes is traced from first-generation facilities with fixed-bed reactors having separate areas for heating and devolatilization, syngas reactions and char gasification, through optimized second-generation reactors consisting of separate sections for the three stages, to third-generation hydropyrolysis reactors with a combined gasification reactor and secondary hydrogen generation and separation. The current status of development work on gasifiers is discussed, noting the availability of first-generation devices, the late development stages of the second generation and the early development status of the third generation. It is pointed out that although gasification technology exists that is ready for use, gasification plants are not in operation due to a range of institutional difficulties.

A.L.W.

A80-46569 A practical and economic method for estimating wind characteristics at potential wind energy conversion sites. C. M. Bhumralkar, R. L. Mancuso, F. L. Ludwig (SRI International, Menlo Park, Calif.), and D. S. Renne (Battelle Pacific Northwest Laboratories, Richland, Wash.). Solar Energy, vol. 25, no. 1, 1980, p. 55-65. 8 refs.

The paper presents a physically based, three dimensional model for estimating wind characteristics at potential wind energy conversion sites. The model incorporates the effect of underlying terrain and it uses available, conventional wind information from selected nearby weather stations. The model is called COMPLEX, and is essentially an objective analysis computer program that interpolates values of wind from observations at irregularly spaced stations. The statistical wind characteristics are estimated from the synthesized hourly winds obtained by using the COMPLEX model in conjunction with a method for reducing the number of variables while retaining most of the information of the original data set. The linear characteristics of the COMPLEX have been used to obtain solutions directly for only the few eigenvectors of the input for any arbitrary set of observations from linear combinations of those solutions. A.T.

A80-46606 Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment. W. R. Aiman, R. J. Cena, R. W. Hill, C. B. Thorsness, and D. R. Stephens (California, University, Livermore, Calif.). *In Situ*, vol. 4, no. 2, 1980, p. 153-163. 10 refs. Contract No. W-7405-eng-48.

A linked-vertical-well method was used for underground coal gasification. The link was provided by a directionally drilled, horizontal borehole. During an initial 7-d air burn, 260 tons of coal were gasified. The resultant gas had a heating value of 102 kJ/mol (115 Btu/scf). During the 47-d oxygen-steam burn, 3900 tons of coal were gasified. The heating value of the resultant gas was 194 kJ/mol (218 Btu/scf). (Author)

A80-47587 Methane recovery from urban refuse. M. L. Wilkey (Argonne National Laboratory, Argonne, III.) and, R. E. Zimmerman. In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 9-13.

The recovery of combustible gases generated in sanitary landfills is discussed with emphasis on the source of the gas, recovery techniques, processing, and utilization options. Consideration is given to the research and development program sponsored by the Department of Energy, including several landfill methane optimization projects, landfill utilization projects, and an information transfer project.

A80-47588 Energy from MSW - The industrial market. E. B. Cohen (New Jersey, Dept. of Environmental Protection, N.J.), R. W. Simkins (Burlington County, Health Dept., N.J.), and J. C.

Anderson. In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers.

Atlanta, Ga., Fairmont Press, Inc., 1980, p. 15-18. 6 refs.

Prospects for energy recovery from solid waste in Burlington County, New Jersey, are discussed with respect to potential customers, final forms of energy, and energy costs. Major requirements to economically competitive energy recovery from municipal solid waste are formulated, and the present status of local refuse derived energy projects is reviewed.

V.L.

A80-47589 Municipal solid waste as an industrial fuel. R. A. Olexsey, G. L. Huffman (U.S. Environmental Protection Agency, Washington, D.C.), and C. C. Wiles (Cincinnati Municipal Environmental Research Laboratory, Cincinnati, Ohio). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers.

Fairmont Press, Inc., 1980, p. 19-24.

Potential applications of municipal solid waste as a fuel for the industrial sector are reviewed with reference to the following combustion processes: (1) co-combustion of processed refuse derived fuel with a fossil fuel in a boiler for production of steam or electricity; (2) co-combustion of densified refuse derived fuel with a fossil fuel in a boiler for production of steam or electricity; (3) combustion of solid waste alone in a special boiler for production of steam; and (4) use of solid waste as a fuel additive in direct heat manufacturing operations. Examples of commercial utilization of municipal solid waste as an industrial fuel are briefly discussed. V.L.

A80-47590 High temperature heat pump applications - Commercial, industrial, and with alternative energy sources. R. C. Niess (Westinghouse Electric Corp., Pittsburgh, Pa.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers.

Atlanta, Ga., Fairmont Press, Inc., 1980, p. 59-65.

A80-47591 An update on the City of Waukesha energy recovery incinerator plant. J. I. Levenhagen (Johnson Controls, Inc., Milwaukee, Wis.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 125-130.

A80-47593 Wood energy systems - An assessment. J. L. Birchfield and W. S. Bulpitt (Georgia Institute of Technology, Atlanta, Ga.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 251-260.

Results of a study concerned with the use of wood as a source of energy are reviewed. Consideration is given to currently available wood waste handling, conveying, and storage systems, wood combustion systems, pyrolysis systems, and wood gasifiers. Availability of wood resource is assessed, and several current research and development programs are mentioned.

V.L.

A80-47594 \* Energy from wood waste - A case study. R. Scola (U.S. Army, Armament Research and Development Command, Dover, N.J.) and K. Daughtrey (NASA, Mashall Space Flight Center, National Space Technologies Laboratories, Bay St. Louis, Miss.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers. Atlanta, Ga., Fairmont Press, Inc., 1980, p. 265-269.

A joint study has been conducted by NASA and Army installations collocated in a dense forest in southwestern Mississippi in order to determine the technical and economic feasibility of using wood waste as a renewable energy source. The study has shown that,

with proper forest management, the timber on government lands could eventually support the total energy requirements of 832 billion Btu/yr. Analysis of the current conversion technologies indicates that the direct combustion spreader stoker approach is the best demonstrated technology for this specific application. The economics of the individual powerplants reveal them as attractive alternatives to fossil fueled plants. Environmental aspects are also discussed.

A80-47595 Peat and wood as fuels - Another form of solar energy utilization. K. Leppa (EKONO, Inc., Seattle, Wash.). In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers.
Atlanta, Ga., Fairmont Press, Inc., 1980, p. 281-285.

A80-47776 LNG cold, an unutilized energy potential (LNG-Kälte, ein ungenutztes Energiepotential). L. Schintgen (Linde AG, Höllriegelskreuth, West Germany). Brennstoff-Wärme-Kraft, vol. 32, June 1980, p. 247-251. In German

The utilization of LNG (liquefied natural gas) cold for electricity generation is evaluated, with particular attention given to the situation in Germany. Consideration is given to the development of LNG cold power plants, and to such issues as investments, costs, and efficiency. The thermodynamic cycle of the process is examined, and the use of conventional LNG evaporation is discussed.

B.J.

A80-48039 # Heat and mass transfer processes during the pyrolysis of antrim oil shale. R. A. Piccirelli (Wayne State University, Detroit, Mich.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-123. 10 p. 23 refs. Members, \$1.50: nonmembers, \$3.00. Contract No. DE-AC20-76LC-10157.

A model of simultaneous heat and mass transfer processes during the pyrolysis of slabs of consolidated Michigan oil shale is presented. The manner in which the transport processes control the yield of pyrolysis product is emphasized; the model parameters are selected to reflect the conditions expected during in situ retorting. A single reaction describes the generation of gaseous pyrolysis product; numerical solution of the model mass transport equations indicates that the pressure and velocity profiles within the shale due to generation of gaseous reaction products can be assumed to be in a quasi-steady state. It is concluded that while the bulk convective transport is not essential to the energy equation, it is important for product yield calculations; the solution also suggests that the heat transfer through the surface convective layer and into the shale slab is the rate limiting process.

A.T.

A80-48166 # Recent activity in U.S. tar sand. L. C. Marchant (U.S. Department of Energy, Laramie Energy Technology Center, Laramie, Wyo.), J. J. Stosur (U.S. Department of Energy, Germantown, Md.), and C. Q. Cupps. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1-10.

A review of the U.S. tar sand resources is presented. The total oil-in-place in 550 occurrences of tar sand in 22 states is estimated to be between 25 and 36 billion barrels, of which at least 80% is located in Utah. The lack of commercial oil production is attributed to the lack of proven technology, marketability of the produced oil, and a moratorium on leasing of federally controlled tar sand properties. Current activities to develop the U.S. tar sand resources include reservoir characterization and evaluation by industry, states, and DOE; oil recovery research by industry and universities; and few field mini-tests and pilot work by industry and DOE.

A.T.

A80-48167 # Tar sands and heavy oil reservoir evaluation using geophysical well logs. W. H. Fert! (Dresser Industries, Inc., Houston, Tex.). In: Energy to the 21st century; Proceedings of the

Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 11-19, 14 refs.

Geophysical well logs and associated interpretive techniques provide in-situ evaluation of several important reservoir parameters in tar sands and heavy oil reservoirs. Information such as lithology variations, reservoir shaliness and cation exchange capacity estimates, silt and fines content, porosity, hydrocarbon saturation and the elastic rock constants can be derived from the response of various well logging devices which can be run in open or cased wellbores. Applicable well logging instrumentation includes resistivity and conductivity-types (induction, dielectric, etc.), gamma ray and spectral gamma ray sondes, acoustic, density, neutron, and pulsed neutron devices. These concepts are illustrated in several field case examples. (Author)

A80-48168 # A mathematical model for the continuous combustion of char particles in a fluidized bed. S. C. Saxena (Argonne National Laboratory, Argonne; Illinois, University, Chicago, III.) and A. Rehmat (Argonne National Laboratory, Argonne; Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 50-56. 7 refs. Research supported by the U.S. Department of Energy and U.S. Environmental Protection Agency.

A fluidized-bed char-combustion system has been developed in which (1) there is only negligible elutriation loss and (2) only ash is selectively discharged from the bed. The system of equations are solved to yield (1) the number of char particles present in the fluidized bed, (2) their size distribution, and (3) the amount of carbon in the bed as functions of (1) char feed rate, (2) feed particle size, and (3) fluidizing-gas velocity. The analysis indicates that the amount of carbon present in the bed is independent of the feed particle size at fixed values of the char feed rate and fluidizing-gas velocity although the number of char bed particles depends upon the feed particle size. Further, the carbon content of the bed and the number of char particles in the bed are found to depend heavily on the char feed rate and the fluidizing-gas velocity. A discrete cut method is employed to compute the particle size distribution and the number of particles present in the bed. The method provides a simplified trial-and-error procedure for those cases in which the rate of change in particle size is a complex nonintegrable function of the particle size.

A80-48169 # Selecting fines recycle methods to optimize fluid bed combustor performance. W. S. Rickman, D. E. Fields, W. L. Brimhall, and S. F. Callahan (General Atomic Co., San Diego, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 57-61. 6 refs. Research supported by the Electric Power Research Institute; Contract No. DE-AT03-76SF-71053.

Testing and analysis of a number of different fines recycle methods for fluid bed combustors has led to a generalized modeling technique which accounts for the effect of pertinent variables in determining overall combustion efficiencies. Computer application of this model has shown the overall process effects of changes in individual operating parameters. Verification of the model has been accomplished in processing while combusting fuels such as graphite and bituminous coal. Solid fuel was typically crushed to 5 mm maximum screen size. Bed temperatures were normally controlled at 900 C; the combustor was an atmospheric unit with maximum in-bed pressures of 0.2 atm. Additional tests used high sulfur coal in a 1.2 meter deep, 850 C atmospheric fluidized bed of limestone, with low recycle rates and temperatures. Close agreement between the model and test data has been noted, with combustion efficiency predictions matching experimental results within 1%. (Author)

A80-48170 # Methods of improving limestone utilization in fluidized-bed combustion. E. B. Smyk, W. M. Swift, W. F. Podolski, K. M. Myles, and I. Johnson (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 62-66. 9 refs. Research sponsored by the U.S. Department of Energy and U.S. Environmental Protection Agency.

A80-48171 # An engineering study on the use of regenerative calcium silicates sorbent for AFB power generation from high sulfur coal. P. J. McGauley and A. S. Albanese (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 72-77.

A80-48172 # Hydration of 'spent' limestone and dolomite to enhance sulfation in fluidized-bed combustion. J. A. Shearer, G. W. Smith, D. S. Moulton, C. B. Turner, K. M. Myles, and I. Johnson (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 78-82. 6 refs. Research sponsored by the U.S. Department of Energy and U.S. Environmental Protection Agency.

A80-48200 # Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities. J. E. Mesko (Pope, Evans and Robbins, Inc., New York, N.Y.). In: Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980. p. 330-336.

Economic analysis of the construction and operation of coal fired steam and by-product electric power co-generation plants, located at individual industrial sites analyzed by the author is being presented. The plants analyzed employ fluidized bed boilers for generation of steam for process and building heating/cooling demands, in conjunction with electric power co-generation. Results of the analysis are presented, using life cycle costs and investment payback periods, pin-pointing the areas, type and magnitude of costs which should be considered in the selection of combustors or systems. Capital and operating costs, and recognized technical and economic barriers are also presented and their effects indicated. Life cycle cost of each of the alternatives analyzed are compared and the expected payback periods for the different size FBC plants and for different annual average production levels are discussed. (Author)

A80-48201 # Circulating fluidized bed boiler. L. D. Fraley, L. N. Do, and K. H. Hsiao (Pullman Kelloga Research and Development Center, Houston, Tex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 337-342.

The circulating bed combustor represents an alternative concept of burning coal in fluidized bed technology, which offers distinct advantages over both the current conventional fluidized bed combustion system and the pulverized coal boilers equipped with flue gas desulfurization. This paper presents the conceptual design of a circulating fluidized bed coal combustor to be used as a steam generator for a power plant. The design variables are selected to optimize the combustor's performance, size and cost. Some advan-

tages of the combustor include good turndown capabilities, high throughput and simplified feeding. The main problem area is in the capacity of cyclones which separate the circulating bed solids from the flue gas. Guidelines for additional development work are recommended.

(Author)

A80-48202 # Design and operation of fluidised bed industrial boilers and hot gas producers. J. Highley, W. G. Kaye, R. C. Payne, and O. M. Willis (Coal Research Establishment, Cheltenham, Glos., England). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc.,

New York, American Institute of Aeronautics and Astronautics, Inc. 1980, p. 343-346.

In 1972 the U.K. National Coal Board initiated a research program to identify and develop improved coal burning systems for the range of hot water and steam raising boilers and hot gas furnaces serving industry. This paper reviews this program with attention given to the development of industrial fluidized bed combustion, packaged shell boiler designs, water tube boiler designs, and hot gas producers.

B.J.

A80-48242 # The direction and scope of the U.S. Department of Energy's surface coal gasification program. C. L. Miller (U.S. Department of Energy, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 630-632.

The Coal Gasification Program is briefly reviewed with reference to the program development strategy, analysis of energy consumption patterns, technological capabilities of coal gasification, and the program plan. The program plan includes: technical support to improving first generation gasifiers and systems, the development of advanced second generation medium-Btu/synthesis gasifiers and gasification systems, and the development of new, sophisticated third generation processes for the production of high-Btu gas.

V.L.

A80-48244 # Flash pyrolysis and gasification of coal through laser heating. W. H. Beattie and J. A. Sullivan (California, University, Los Alamos, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 637-641. 7 refs. Research sponsored

by the U.S. Department of Energy.

Experimental results obtained from the rapid pyrolysis of finely powdered coal are presented. Heating the coal at rates of 1000-10,000 C/s in an inert atmosphere of argon results in pyrolysis at temperatures between 400 and 800 C. The gases evolved are primarily CO; H2, and CH4 with lesser amounts of CO2 and other light hydrocarbons. Mass spectrometry is used to determine the composition of the evolved gases. The optimum flux for laser pyrolysis of coal was found to be 250 W/sq cm. Results from experiments wherein the char created by pyrolysis is gasified to CO in an atmosphere of CO2 are also presented. The information obtained from these experiments will be used to test concepts for the use of concentrated sunlight to produce fuel gases from coal.

(Author)

A80-48245 # Fast fluid bed coal gasification in a process development unit. G. J. Snell and C. L. Chen (Hydrocarbon Research, Inc., Lawrenceville, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 642-647. 11 refs.

Results of Phase I Fast Fluid Bed coal gasification development program completed under the sponsorship of the United States Department of Energy are briefly reviewed. A fast fluid bed gasifier is a vertical, moderately dense phase flow reactor in which gas and solid phases are maintained in a highly turbulent fluidized state. Some of the important results of the Phase I program are: both anthracite and Illinois coal were gasified; good velocity and gasification rates in the design range were achieved; the PDU was found to be easy to control and could adapt to rapid changes over a range of at least 3:1; product gas heating values in the vicinity of 100-130 Btu/SCF were achieved.

A80-48246 # Historical development of the U-GAS process at the IGT pilot plant. M. K. Vora, W. A. Sandstrom, and A. Rehmat (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 648-653. 13 refs. Research sponsored by the U.S. Department of Energy, American Gas Association, and Memphis Light, Gas, and Water Division of the City of Memphis.

The Institute of Gas Technology (IGT) U-GAS process for medium-Btu gas offers a means to achieve a clean fuel from coal with minimal particulate and sulfur dioxide flue-gas emissions. The U-GAS process combines a single-stage fluidized-bed gasifier with an ash agglomerating mechanism that achieves high carbon conversions. In the more than 100 pilot plant tests completed, 670 tons of caking coal and 170 tons of subbituminous coal have been processed. Fuel conversions in excess of 90% have been achieved with steady-state operation at pressures to 60 psia and temperatures to 2000 F.

(Author)

A80-48247 # Helium-topping/organic bottoming - Advanced power generation system - Exergetic/energetic analysis. R. Tabi (New York Institute of Technology, Old Westbury, N.Y.), and J. E. Mesko (Pope, Evans and Robbins, Inc., New York, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 660-666. 7 refs. Research supported by the Institute of Gas Technology.

Thermodynamic analysis based on the first and second laws of thermodynamics of an advanced power-generation system, as applied to or related to coal conversion is presented. The system employs a two-stage atmospheric fluidized-bed furnace, the lower stage fluidized-bed cell operating at 2000 F and the upper stage at 1550 F. Helium is the working fluid for the closed gas turbine topping cycle. Exhaust energy is recuperated in a helium recuperator and in a helium-to-organic fluid boiler, where the working fluid of the bottoming cycle is Flurinol-85. With a net output of 475.7 MW of the combined system, the plant heat rate is 8550 Btu/kWh, and the overall power plant efficiency is 39.9 percent. (Author)

A80-48274 # Wind energy capacity of a single airfoil with vertical axis on a circular track. D. Palmgren and D. R. Otis (Wisconsin, University, Madison, Wis.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 840-845. 7 refs.

A vertical axis wind energy conversion system consists of a single vertical airfoil traveling at constant speed around a horizontal circular track. A computer simulation determines thrust, normal force and power coefficients, and airfoil angle of attack for two standard NACA airfoils for airfoil speeds up to 10 times the wind speed. The airfoil is articulated for optimum performance. The simulation shows that for the articulated case, maximum average thrust is attained at airfoil speeds of seven times the wind speed, and at this speed the articulated airfoil produces 43% more thrust (and

power) than the nonarticulated airfoil. Angle of attack, thrust force and normal forces are presented as a function of track position.

(Author)

A80-48275 # Economics of wood energy systems for industries. B. S. Dixit and W. S. Bulpitt (Georgia Institute of Technology, Atlanta, Ga.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc.,

1980, p. 846-852. 6 refs.

The economics of wood energy systems is investigated by a consideration of the various factors including the investment costs, operating costs, etc., and the characteristics of wood fuel. Various thermal conversion systems are discussed. An analysis on three cases including direct combustion wood system, wood gasifier system, and cogeneration system is performed and the important factors that influence the economics of wood systems are discussed. Based on the annual savings and the cost of cogeneration electricity, it is found that wood energy systems are economically feasible at current prices of gas and oil. (Author)

A80-48276 # Start-up consideration in utility use of a refuse derived fuel. F. Hasselriis, J. Lyons, and C. S. Konheim. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 853-859.

This paper describes the phased start-up of firing a refuse derived fuel. The fuel is burned in a 86 megawatt utility boiler; the process of producing a fuel of the high BTU value with a low ash and moisture content is shown. The paper discusses characteristics, handling, storing, metering, pneumatic transport of the fuel, burner design, observed behavior of the fuel, slagging characteristics, and the combustion performance at feed levels of 2% to 10% of the boiler input. The upper limit was determined in initial phases by environmental restrictions on sulfur content of the fuel. Particulate emissions were found to be below standards. Observations of the combustion, fly ash and slagging characteristics show that the ECO-FUEL(R)II can be effectively burned with oil in a utility boiler at high pressure (1500 PSIG) and a high temperature (1000 F) superheat.

A80-48277 # Alternatives for heat supply in biomass energy conversion systems. P. De Marchi Desenzani (Pavia, Università, Pavia, Italy). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 860-864.

The paper discusses the effects of using different heat sources upon thermoeconomics of anaerobic digestion processes. While a relevant high-grade energy input is associated to biomass production, the processing of wasted biomass is regarded as an energy upgrading practice. Heat recovering from suitable power cycles is found to be the most attractive solution for heat supply, except for those cases when a very low cost alternative heat source is available: because of the interest in the Italian situation, the case of geothermal heat is examined. (Author)

A80-48278 # Kelp processing and biomethanation technology. J. R. Forro (General Electric Co., Re-entry Systems Div., Philadelphia, Pa.), M. Hart (U.S. Department of Agriculture, Western Regional Research Center, Albany, Calif.), and D. P. Chynoweth (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Astronautics, Inc., 1980, p. 865-869. 11 refs. Research sponsored by the Gas Research Institute and U.S. Department of Energy.

This paper summarizes several experimental aspects involved in the conversion of kelp (Macrocystis pyrifera) to substitute natural gas. It describes approaches undertaken to minimize process energy consumption and to maximize energy output both in terms of rates and yields. Total biomass utilization is also being investigated thru utilization of process underflows. The results of this Gas Research Institute sponsored multidisciplinary study indicate that significant methane can be obtained thru controlled anaerobic digestion of kelp. (Author)

A80-48291 # The HYGAS process to produce pipeline gas from coal. F. S. Lau and J. Meek (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 946-951. 7 refs. Research sponsored by the U.S. Department of Energy and Gas Research Institute.

The HYGAS process has been developed as a means of efficient coal gasification to convert all types of U.S. coals to high-Btu substitute natural gas. The process uses a stage fluidized-bed steam/oxygen gasifier which operates at elevated pressures and features a novel coal slurry feeding technique that eliminates the need for lockhoppers. The high-pressure staged reactor maximizes direct methane production in the gasifier, which improves the overall process efficiency. Six coals representing major coal reserves of the United States, have been successfully processed in the HYGAS pilot plant. Typical test results are presented.

A80-48292 # The CS/R advanced SNG hydrogasification process. J. Silverman, J. Friedman, D. R. Kahn (Rockwell International Corp., Energy Systems Group, Canoga Park, Calif.), D. Rimmer, and R. Matyas (Cities Service Research and Development Co., Tulsa, Okla.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle. Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 952-958. 12 refs. Contracts No. EX-77-C-01-2518; No. ET-78-C-01-3125.

Development effort is continuing on the Cities Service/Rockwell (CS/R) Advanced Hydrogasification System with emphasis shifting from reactor development to process optimization. An 18-ton/day integrated process development unit is under construction and will be operational in 1981. Concurrently, an extensive commercial-scale process optimization activity is underway to select the proper reactor operating parameters and subsystem unit processes. Development test data indicate the feasibility of two process options: either the production of SNG as the sole major product, or the coproduction of SNG and benzene. Test data indicate that as much as 15% of the product can be produced as benzene whose market value is approaching \$12/1,000,000 Btu. The percent of total product as benzene can be precisely controlled by selection of reactor operating parameters. Process economic studies show that maximizing the coproduction of benzene will lower the price of SNG by at least \$1.00/1,000,000 Btu. At 11.2% carbon conversion to benzene, the cost of gas in mid-1979 dollars is estimated to be in the \$3.40 to \$3.80/1,000,000 Btu range, using a \$1.00/1,000,000 Btu bituminous coal, for a corresponding total plant investment of \$1.2 to \$1.4 billion. Even in the total gas mode (without benzene production), the cost of SNG is an attractive \$4.87/1,000,000 Btu.

A80-48293 # Status of peat Biogasification development. M. G. Buivid, D. L. Wise (Dynatech R/D Co., Cambridge, Mass.), M. J. Kopstein (U.S. Department of Energy, Washington, D.C.), and A. M. Rader. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 959-963. 28 refs.

The status of a four-phase development program to confirm that biogasification is a technical and economical process for the conversion of peat into pipeline quality methane is presented. The biogasification of peat is based on a two-stage process. In the first processing stage (assumed to follow hydro-mining) an oxidative pretreatment of peat breaks down the lignocellulosic structure to water soluble, lower molecular weight organics, i.e., simple aromatics, wood sugars, and carboxylic acids. The exothermic reaction provides the necessary heat to maintain moderate pretreatment temperatures of less than 180 C. Unreacted peat solids are separated (to be processed as boiler fuel), while the recovered liquid, containing the soluble organics, is converted to methane and carbon dioxide by conventional anaerobic fermentation is the second stage of the process. A significant advantage of the biogasification process is that technical difficulties of peat dewatering (to greater than 50% solids) necessary for conventional gasification are eliminated. Biogasification can be readily integrated into an environmentally acceptable and economically viable peat utilization concept involving hydromining, slurry transport, and wet processing.

A80-48294 # Peat char gasification - Laboratory and PDU-scale studies. D. V. Punwani, S. A. Weil, E. J. Pyrcioch, and S. P. Nandi (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 964-969. 5 refs.

This paper presents the results of gasification tests conducted with chars of Minnesota, North Carolina, and Maine peats. Laboratory-scale tests were conducted to obtain differential kinetics data. Integral-bed kinetic data were obtained from gasification tests in a 6-inch-diameter fluidized-bed Process Development Unit (PDU) using steam and oxygen. Correlations are presented for the differential kinetics data obtained for gasification of the three peat chars with steam-hydrogen mixtures and synthesis gas. A kinetic description of the PDU data is also presented. (Author)

A80-48295 # Removal of metals from coal ash. T. M. Gilliam and R. M. Canon (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 970-977. 8 refs. Research sponsored by the Electric Power Research Institute; Contract No. W-7405-eng-26.

Results are shown for the development work being performed at Oak Ridge National Laboratory on the recovery of metals from fly ash and gasification ash. Data shown are for the treatment of ash via direct acid leach. At reflux conditions the maximum extractions for aluminum and iron (the two major metals) were 50 and 80%, respectively, for the fly ash studied. Removals of aluminum and iron for the gasification ashes were greater than 80% under similar conditions. Ambient-temperature leaches gave high extraction yields for gasification ashes with high lime content. (Author)

A80-48296 # Indirect liquefaction via the Avco coal gasification system. G. A. White (Ralph M. Parsons, Co., Pasadena, Calif.), D. B. Stickler, C. W. von Rosenberg, Jr., and R. E. Gannon (Avco Everett Research Laboratory, Inc., Everett, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 978-984. 7 refs.

The production of liquid fuels from coal utilizing an advanced coal gasification process is described. The Avco gasification process converts coal to synthesis gas in a matter of milliseconds by way of high temperature, rapid heating of the pulverized coal in a fast entrained flow reaction sequence. In the first stage of the reactor, char, recycled from the second stage, is combusted with oxygen to provide the energy to drive the rapid coal pyrolysis in the second stage of the process. By minimizing partial combustion reactions,

oxygen requirements are virtually limited to the heat requirements of the system. In Stage I and in part of Stage II, the reactor walls are protected by slag to avoid problems of refractory corrosion and to allow these portions of the gasifier to operate at high temperature to optimize conditions for high pyrolysis yields. In the indirect liquefaction process selected for illustration, the synthesis gas from the gasifier was converted to methanol via the Chem Systems liquid phase process. Using pyrolysis data that was recognized as being conservative, process efficiency for converting coal to methanol is calculated. Projected cost advantages due to smaller size process equipment and minimal oxygen use are cited. (Author)

A80-48315 # Electric power generation using low temperature geothermal resources and wood residues. K. L. Boren (Geo-Products Corp., Oakland, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1125-1131. 8 refs.

A80-48319 # Wind resource assessment in the upper Skagit River Valley of Washington. S. D. Veenhuizen, J.-T. Lin (United Industries Corp., Bellevue, Wash.), and A. T. Yamagiwa (Seattle City Light, Seattle, Wash.). In: Energy to the 21st century? Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1143-1148.

A80-48323 # Potential for biological conversion of biomass to liquid fuels. E. J. Nolan (General Electric Co., Philadelphia, Pa.) and A. E. Humphrey (Pennsylvania, University, Philadelphia, Pa.). In: Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1164-1169.

A80-48324 # Fermentation ethanol as a petroleum substitute. L. Goldstein, Jr., A. V. Carvalho, Jr., S. C. Trindade, and A. Bonomi (Centro de Tecnologia Promon, Rio de Janeiro, Brazil). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1170-1177. 7 refs.

The status of the Brazilian ethanol program is reviewed. Consideration is given to the details of ethanol production, and to the utilization and distribution of ethanol in Brazil.

B.J.

A80-48331 # The role of refuse derived fuel /RFD/ as an alternative energy source for district heating and power generation. O. O. Ohlsson (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1215-1219. 7 refs.

A80-48332 # Georgetown University's experience in the atmospheric fluidized bed combustor technology. D. J. Roy (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1220-1226.

An atmospheric fluidized bed combustor is the primary heat source for the Georgetown University steam supply. The combustor

burns high sulfur coal with emissions that are environmentally acceptable. Attention is given to plant problems and modifications, including grid plate performance, the cinder trap reinjection process, the boiler bed antierosion baffles, the control system status, the flyash removal system, and the flyash reinjection system.

B.J.

A80-48340 # Results from the Hoe Creek No. 3 underground coal gasification experiment. C. B. Thorsness, R. W. Hill, R. J. Cena, W. R. Aiman, and D. R. Stephens (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc.,

New York, American Institute of Aeronautics and Astronautics, Inc. 1980, p. 1284-1292. 11 refs. Contract No. W-7405-eng-48.

In this paper we describe results from the Hoe Creek No. 3 underground coal gasification test. The experiment employed a drilled channel between process wells spaced 130 ft apart. The drilled channel was enlarged by reverse combustion prior to forward gasification. The first week of forward gasification was carried out using air injection, during which 250 tons of coal were consumed yielding an average dry product gas heating value of 114 Btu/scf. Following this phase, steam and oxygen were injected (generally a 50-50 mixture) for 47 days, during which 3945 tons of coal were consumed at an average rate of 84 tons of coal per day and an average dry gas heating value of 217 Btu/scf. The average gas composition during the steam oxygen phase was 37% H2, 5% CH4, 11% CO, and 44% CO2. Gas recovery was approximately 82% during the test, and the average thermochemical efficiency was near 65%.

(Author)

A80-48341 # Theory of reverse combustion along fissures in fuel which gasifies at depth. D. M. Shearer and R. C. Corlett (Washington, University, Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1293-1297. 6 refs. Contract No. ET-78-5-03-1840.

An analytic theory of reverse combustion propagating along a narrow channel in fuel which gasifies at depth, leaving a porous and inert matrix, is presented. The gasified fuel burns in thin flame lavers along the channel wall. Propagation rate is determined by equating reactant residence time and characteristic chemical time in that portion of the reacting flame layer concordant with the forward heat conductive zone in the solid. Stability considerations suggest that the flame is stable only when fuel rich. This leads to a parameter which must be exceeded for propagation to occur at all. Even when this criterion is satisfied, propagation is stable only between lower and upper limits of upstream gas velocity, each of which correspond to a stoichiometric condition. A further condition that the flame thickness not exceed the channel half-width is derived. The theory is in excellent qualitative agreement with previously repeated results of experiments with atmospheric air and paraffin saturated firebrick. Preliminary quantitative comparison is satisfactory. (Author)

A80-48342 # A successful eastern in situ coal gasification field trial. L. A. Schrider and J. A. Wasson (Morgantown Energy Technology Center, Morgantown, W. Va.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1298-1303. 6 refs. Research supported by the U.S. Department of Energy.

For the first time in the northeastern United States, a 900-foot deep, 6-foot thick, swelling, eastern bituminous coal has been gasified successfully in situ. The relatively small-scale field test, Pricetown I, affected the equivalent of 735 tons of a high-sulfur, high-ash section of the Pittsburgh coal seam near Pricetown, Wetzel County, West Virginia, during the 4-month burn. A methane-rich gas with an average heating value greater than 200 Btu/cf was produced

at low-flow rates during operations to enhance the coal seam permeability by reverse combustion. During the high flow rate gasification phase, a gas with an average heating value of 127 Btu/cf was produced, resulting in an average energy production of 510.9 MMBtu/day. Initial test results and plans for continued development of this alternative energy source are discussed. (Author)

A80-48343 # A water-influx model for UCG with spalling-enhanced drying. D. W. Camp, W. B. Krantz (Colorado, University, Boulder, Colo.), and R. D. Gunn (Wyoming, University, Laramie, Wyo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1304-1310. 19 refs. Research supported by the U.S. Department of Energy.

The development of a better understanding and a predictive model for water influx is pivotal in scaling up the linked vertical well UCG process, since water influx strongly affects gas quality. A water-influx model is developed here which incorporates radial permeation of water through the coal seam, and steam generation by spalling-enhanced drying of the coal and overburden. This random spalling process which enhances drying by exposing fresh wet surface is described by a surface-renewal model. A cavity-growth model based on coal consumption ties together these mechanisms. The model predictions are found to agree quite well with the measured daily and total water influx for the available field tests. (Author)

A80-48344 # An investigation of simultaneous heat and mass transfer in subbituminous coal. B. A. Kashiwa and F. H. Harlow (California, University, Los Alamos, N. Mex.). In: Energy to the 21st century, Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1311-1314. 9 refs.

The purpose of the present study is to advance the basic understanding of underground coal conversion by means of an investigation of the drying behavior of saturated coal at temperatures above 100 C and below volatilization. Experiments are described in which New Mexican subbituminous coal was dried at 200 C. Data are shown for temperature versus distance from the heated face for various times and for water removed versus time. Experimental data are compared with computer calculations. The theoretical model assumes infinite resistance to water movement in saturated coal and zero flow resistance to steam in dried coal. The comparison of experimental data to theoretical calculations shows good agreement.

A80-48345 # Characterization of a potential underground coal gasification site in the State of Washington. L. C. Bartel, T. L. Dobecki (Sandia Laboratories, Albuquerque, N. Mex.), and R. Stone (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1880. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1315-1320, 14 refs. Contract No. DE-AC04-76DP-00789.

A80-48346 # Sorption of moisture and methane on Fruitland coal. A. Heller, G. R. B. Elliott (California, University, Los Alamos, N. Mex.), and L. F. Brown (Colorado, University, Boulder, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York; American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1327-1330. Research supported by the U.S. Department of Energy.

Water sorbed (held) on coal shows wide variations in thermodynamic activity depending on the concentration of moisture in the coal pores and the history of the coal sample. This behavior has important implications for underground coal conversion. This paper presents experiments in which the isopiestic balance was used to perform thermodynamic measurements of moisture sorption on coal (Fruitland subbituminous). The application of the isopiestic balance for methane retention in moist coal is also reported.

B.J.

A80-48379 # Advanced process development in coal lique-faction. R. H. Fischer (U.S. Department of Energy, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1539-1542.

DOE is engaged in a program to develop technology to commercialize the liquefaction of coal. The development activities are to: (1) explore the innovative process concepts having a potential for significant cost reduction in synfuel production and (2) lay the foundation for further technology improvements by providing a fundamental understanding of the chemistry of coal, conversion processes. Two process development activities are reviewed: indirect liquefaction and advanced direct hydroliquefaction.

A80-48380 # Advanced coal liquefaction processes emphasize low hydrogen consumption. H. D. Schindler, M. C. Sze, R. H. Long, and H. Unger (Lummus Co., Bloomfield, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1543-1556. Contracts No. EX-76-C-01-2514; No. DE-AC02-79ET-14804.

Two advanced coal liquefaction processes are described: the Lumus Clean Fuels from Coal process and the Advanced Two Stage Liquefaction process. The main advantage of these two processes is a more efficient use of hydrogen, permitting a greater fraction of the hydrogen utilized in liquefying the coal to go into desirable distillate products. As a result, the yield of liquid products is increased as gas make is reduced; at the same time the quality of distillates, as measured by heteroatom content, is improved.

B.J.

A80-48381 # Disposable catalysts in the solvent refined coal processes. R. P. Anderson (Pittsburg and Midway Coal Mining Co., Merriam, Kan.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1557-1561. 8 refs. Contracts No. EX-76-C-01-0496; No. DE-AC22-79ET-14800.

Some coals are particularly desirable feeds for the SRC processes because of the chemical characteristics of the organic phase and/or the concentration, composition, and particle size of the mineral constituents. Unfortunately, some coals could be attractive candidates for the SRC processes except that they lack the association with naturally occurring catalytic materials and therefore give poor liquefaction yields. Such coals could become attractive candidates for the SRC processes by the addition of low cost disposable catalysts. The addition of low cost iron compounds in expectation of improved yields and operability was investigated in both the SRC I and SRC II process. Pyrite was the most effective material investigated and finely divided pyrite (about 1 micron) was more effective than coarsely ground (about 75 microns) material.

(Author)

A80-48382 # Approach to steady-state solvent composition in the SRC-I coal liquefaction process. R. W. Skinner and E. N. Givens (Air Products and Chemicals, Inc., Allentown, Pa.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety

Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. (A80-48165 21-44) New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1562-1566. 9 refs

A80-48383 # Chem Systems' liquid phase methanol process.

M. E. Frank (Chem Systems, Inc., New York, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1567-1572. Research supported by the Electric Power Research Institute.

The Liquid Phase Methanol (LPMeOH) process differs significantly from presently available technologies. This process incorporates an inert hydrocarbon liquid into the reactor in the presence of a heterogeneous catalyst to effect high conversions of hydrogen and carbon monoxide to methanol. The liquid serves to control the reaction temperature by converting the sizable reaction exothermicity into a moderate temperature gain and allows maximum recovery of this reaction heat for use in the overall process. The LPMeOH process is particularly suited for coal-derived synthesis gases which are usually hydrogen deficient. (Author)

A80-48384 # Mobil methanol-to-gasoline process. D. Liederman, S. Yurchak, J. C. W. Kuo, and W. Lee (Mobil Research and Development Corp., Paulsboro, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 1573-1578. 8 refs.

The recent development of the methanol-to-gasoline process is reviewed. The fixed-bed process has been successfully demonstrated in the laboratory and is ready for commercialization. Several commercial applications are under development and others are being considered. The fluid-bed process is planned for scale-up to a 100-barrels-per-day pilot plant in Germany. A commercial fixed-bed plant is planned for a gas-to-gasoline installation in New Zealand.

B.J

A80-48385 # Liquid products from peat pyrolysis. D. A. Duncan and J. Paganessi (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1579-1585. 5 refs.

IGT has conducted experimental work on a small process development unit to characterize the oil produced by low-severity peat pyrolysis. Peat gasification has been carried out by entrained-flow hydrogenation at temperatures of 1200-1400 F, residence times of 2-10 sec, and pressures of 100-500 psig. The quality of the oil produced varies considerably within this range of conditions. High hydrogen partial pressures and reactor temperatures increase the content of light aromatics, particularly benzene, at the expense of oxygenated species such as phenols and cresols. At very low cracking severities there is also a considerable yield of organic acids and ketones.

B.J.

A80-48402 # Perspective on the DOE fusion synthetic fuels program. R. N. Ng (U.S. Department of Energy, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1658-1661. 9 refs.

An overview of the DOE fusion synthetic fuels program is presented with attention given to the identification of DOE contractors, short-term and long-term program objectives, and technical concepts. The character of fusion energy is briefly explained, and attention is given to how its physical characteristics make it amenable for application to the production of chemical

synthetic fuels. It is maintained that there should be a large commercial-market demand for synthetic fuels at the turn of the century.

A80-48427 # The Department of Energy's major project coal liquefaction program. L. M. Joseph (U.S. Department of Energy, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1808-1811.

The Department of Energy's (DOE) program in coal liquefaction is a key element in efforts to create a strategic technological position regarding the nation's energy supply. The major projects incorporating the best technologies will enable commercial private interests to build profitable plants with confidence. These projects will be designed to meet all applicable federal and state environmental regulations, producing clean fuels for utilities and transportation requirements. Two large plants - the Exxon Donor Solvent pilot plant in Baytown, Texas, and the H-Coal pilot plant in Catlettsburg, Kentucky - initiate operations during 1980. The two large demonstration plants for Solvent Refined Coal (SRC) are in the design phase with both plants scheduled for startup in 1984. The SRC-I plant produces mainly a clean solid fuel and will be built near Newman, Kentucky. The SRC-II plant which produces a liquid product will be built near Morgantown, West Virginia. (Author)

A80-48428 # Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program. B. R. Rodgers, M. S. Edwards, C. H. Brown, P. K. Carlson, W. R. Gambill, T. M. Gilliam, J. M. Holmes, R. P. Krishnan, and L. F. Parsly (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1812-1817. Contract No. W-7405-eng-26.

Oak Ridge National Laboratory has assessed current R&D activities and developed recommendations for R&D activities needed for adequate Solvent Refined Coal (SRC) demonstration plant designs. Four classes of R&D activities are suggested: (1) the continuation of present and planned activities, (2) the coordination of present and proposed activities and results, (3) the extension and redirection of activities not involving major equipment purchase or modifications, and (4) new activities. A summary of recommendations is presented.

A80-48429 # H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal. A. G. Comolli, P. Ganguli, and M. Merdinger (Hydrocarbon Research, Inc., Lawrenceville, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1818-1823. Research supported by the U.S. Department of Energy, Commonwealth of Kentucky, Electric Power Research Institute, Ashland Oil, Inc., Mobil, Conoco, Ruhrkohle AG, and Standard Oil Company of Indiana.

The primary objectives of processing Kentucky No. 11 coal at equilibrium catalyst conditions were to develop parameters for operating with this coal in the 600 ton/day H-Coal pilot plant at Catlettsburg, Kentucky; to compare Kentucky No. 11 coal and Illinois No. 6 coal; and to establish a basis for commercial design. It was found that the process development unit was operated successfully with Kentucky No. 11 coal in the syncrude mode at catalyst equilibrium for a sustained 30 day period. Steady state product yields were demonstrated on the 26th day of operation.

A80-48430 # Exxon Donor Solvent Coal Liquefaction Process - Development Program Status, W. R. Epperly, K. W. Plumlee, and D. T. Wade (Exxon Research and Engineering Co., Florham

Park, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash.; August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1824-1831. 25 refs.

The status of the Exxon Donor Solvent Coal Liquefaction Process Development Program is reviewed. The status of the laboratory and engineering research and development studies along with an up-to-date status of the 250 T/D large pilot plant demonstration is presented. The process description includes discussions of coal feed flexibility and product flexibility. Potential product utilization schemes, including direct utilization and various conventional upgrading routes, are surveyed. The project environmental program philosophy and studies are described. The economic outlook for the EDS process and the effects of various bases are presented, concluding with consideration of the prospects for commercialization. (Author)

A80-48431 # LC-Fining of solvent refined coal - SRC-I and short contact time coal extracts. J. D. Potts, K. E. Hastings, R. S. Chillingworth (Cities Service Co., Tulsa, Okla.), and H. Unger (C-E Lummus Co., New Brunswick, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 1832-1839. 9 refs. Contract No. DE-AC22-76ET-10135.

Cities Service became involved in coal liquefaction technology through its proprietary catalytic hydrogenation process which is called LC-Fining (Lummus-Cities Fining). Successful application of this technology for upgrading coal extracts has led to the development of a coal liquefaction process - two-stage liquefaction. Concurrently, the concept of short contact time coal extract processing was developed by other researchers. This study describes the results of processing both conventional solvent refined coal extract (SRC-1) and short contact time coal extract. Both coal extracts have been run at several space velocities, temperatures, and total reactor pressures for comparative purposes. The effect of catalyst deactivation has also been considered. The short residence time coal extract was run in both a deashed and non-deashed mode of operation.

A80-48432 # Heat transfer in slurry preheaters for coal liquefaction plants. A. T. Talwalkar, A. Ambegoankar, R. Dihu, and K. Gandhi (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1840-1846. 10 refs. Contract No. EX-76-C-01-2286.

The objective of the work done at the Institute of Gas Technology (IGT) was to evaluate the existing data with a view of developing a state-of-the-art design procedure for the slurry preheater. Most of these data came from the Solvent-Refined Coal (SRC) pilot plant in Wilsonville, Alabama. Apparent heat transfer coefficients (happ) were calculated from heat balances over small segments of the tube length using the reported coil skin and bulk fluid temperatures. The slurry viscosity was calculated using a mathematical model that simulates the coal-oil slurry viscosity variations with the temperature. It is concluded that more data are needed on the rheology and heat transfer characteristics of coal-solvent slurries to develop design correlations for preheaters. (Author)

A80-48433 # Reaction modelling and correlation for flash hydropyrolysis of lignite. B. Bhatt, P. T. Fallon, and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1847-1852. 7 refs.

A reaction model, based on a single coal particle surrounded by H2 gas, is developed for the hydrogenation of lignite. Conversion data from 83 experimental runs conducted at various pressures, temperatures, particle residence times and gas residence times are correlated to calculate activation energies and to obtain one set of kinetic parameters. A single object function formulated from the weighted errors for the four dependent process variables, CH4, C2H6 BTX, and oil yields, was minimized using a program containing three independent iterative techniques. The results of the nonlinear regression analysis for lignite show that a first-order chemical reaction model with respect to C conversion, with a production and a decomposition step for each of the four products, satisfactorily describes the dilute phase hydrogenation. The mechanism, the rate expressions, and the design curves developed can be used for scale-up and reactor design.

A80-48447 # Development of a falling-bed fusion blanket system for synthetic fuel production. J. F. de Paz, Y. A. Gohar, and H. L. Schreyer (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1929-1937. 10 refs. Research supported by the U.S. Department of Energy.

A high-temperature fusion blanket and heat exchanger system is being developed for non-electrical applications of fusion power. It is proposed to use a falling stream of ceramic pebbles as the heat transport medium. The present paper addresses several issues related to the reliability of bulk solids flow, the thermal design of the heat exchanger, the thermal shock effects on the ceramic pebbles and the structural behavior of the blanket elements. Value ranges for the pertinent design parameters are obtained that meet performance requirements in the above areas. In addition, a comparison of the relative advantages of using a D-D driver, as opposed to D-T, is given.

A80-48516 # Recovery of ethanol from fermentation broths using selective sorption-desorption. W. W. Pitt, Jr. and D. D. Lee (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2363-2367. Contract No. W-7405-eng-26.

An ethanol-water separation technique is described which involves the use of solid materials to selectively remove ethanol from fermentation broths. The subsequent stripping of the ethanol from the sorbent with a dry gas dramatically reduces the energy required for the separation. Two solid sorbents have been investigated: (1) a commercially available divinyl benzene cross-linked polystyrene in bead form and (2) an experimental molecular sieve with hydrophobic properties. The sorption/desorption characteristics of these two sorbents are described, and their incorporation in an ethanol recovery process is evaluated.

A80-49537 Recycling World Congress, 2nd, Manila, Philippines, March 19-22, 1979, Proceedings. Congress sponsored by the National Science Development Board of the Philippines, Bureau International de la Récupération, U.S. Bureau of Mines, et al. Conservation and Recycling, vol. 3, no. 3-4, 1979, 283 p.

The congress concentrated on the technical, economic, and organizational aspects of the recycling of solid wastes, including metal scrap, municipal refuse, waste glass and plastics, wood waste, and organic wastes. Papers are presented on the development of separation methods and system design for the recycling of solid wastes, the producing mechanism, separative and fuel characteristics of municipal refuse, wood waste gasification as a source of energy,

and the development of a methane fermentation process for organic wastes.  $\mbox{V.L.}$ 

A80-49539 The producing mechanism, separative and fuel characteristics of municipal refuse. S. Iwai, H. Takatsuki, and S. Urabe (Kyoto University, Kyoto, Japan). (Recycling World Congress, 22nd, Manila, Philippines, Mar. 19-22, 1979.) Conservation and Recycling, vol. 3, no. 3-4, 1979, p. 249-257.

The mechanism of municipal refuse production was investigated by examining the close correlation between products and wastes. Consequently, effects of the variation of the constituents of municipal refuse on its characteristics for the recovery of valuable materials by means of its mechanical sorting, as well as for recovering its thermal energy, regarded as fuel, were studied. An estimation method of the average constituents of municipal refuse was proposed on the basis of national statistical data of production, export, import and re-use in Japan. An investigation was next carried out, at a pilot plant at Kyoto, into the efficiency of mechanical refuse sorting by utilizing several experimental systems consisting of pulverizers, shredders, wind separators and drum screens etc. Furthermore, the characteristics of thermal decomposition and combustion of the refuse as fuel were experimentally revealed after assuming its combustible portion to be a model mixture of cellulosic and plastic materials. Finally, the feasibility and troublesome points of re-usage of municipal refuse are discussed, together with points of potential difficulty. (Author)

A80-49540 Wood waste gasification as a source of energy.

A. G. Buekens (Brussel, Vrije Universiteit, Brussels, Belgium) and H. Masson (Bruxelles, Université Libre, Brussels, Belgium). (Recycling World Congress, 2nd, Manila, Philippines, Mar. 19-22, 1979.) Conservation and Recycling, vol. 3, no. 3-4, 1979, p. 275-284. 6 refs.

Wood waste and agricultural material gasification technology is reviewed with reference to the gasifier types, design, and construction, process control, properties of the feedstock, operating problems, and construction materials. Wood gasifiers are evaluated in terms of heat balance, thermal efficiency, and properties of the produced gas.

V.I.

A80-49545 Development of a methane fermentation process for organic wastes. T. Oyamoto and H. Kuno (Mitsubishi Heavy Industries, Ltd., Tokyo, Japan). (Recycling World Congress, 2nd, Manila, Philippines, Mar. 19-22, 1979.) Conservation and Recycling, vol. 3, no. 3-4, 1979, p. 469-479. 7 refs.

The application of a methane fermentation process to organic waste, such as agricultural and stock-breeding waste, is discussed with reference to an actual methane fermenter developed for an orange-canning works with a treatment capacity of 100 t of oranges per day. The fermenter produces 250-300 billion cu m of gas (60-65% CH4 and 35-40% CO2) per day with a calorific value of 5100 to 5600 kcal per billion cu m. An economic evaluation of the methane fermentation process based on 10 t (dry base) of organic waste per day is presented.

A80-49626 The flash hydropyrolysis of lignite and subbituminous coals to both liquid and gaseous hydrocarbon products. P. T. Fallon, B. Bhatt, and M. Steinberg (Brookhaven National Laboratory, Upton, N.Y.). (American Chemical Society, National Meeting, 178th, Washington, D.C., Sept. 9-14, 1979.) Fuel Processing Technology, vol. 3, Aug. 1980, p. 155-168. 8 refs. Contract No. EY-76-C-02-0016.

A80-49627 Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves. D. G. Jones and H. Rottendorf (Commonwealth Scientific and Industrial Research Organization, Div. of Process Technology, North Ryde, New South Wales, Australia). Fuel Processing Technology, vol. 3, Aug. 1980, p. 169-180. 7 refs.

Batch autoclave experiments have shown that Liddell coal will dissolve in tetralin under mild conditions of temperature and pressure. In the presence of a catalyst and an initial (cold) hydrogen pressure of 2.7 MPa at least 80% dissolution is achieved for both untreated and demineralized coals after reaction for 4 h at 370 C. The extent of reaction depends strongly on temperature (up to 370 C) and reaction time (up to 4 h), thereafter increasing only slowly with increases in these parameters. Total reaction times of up to 12 h, and maximum temperatures up to 450 C were employed. Increasing the initial (cold) pressure from 3 to 18 MPa raises the amount of coal dissolved, after 4 h, from 81 to 92%. (Author)

A80-49628 Average chemical structure of mild hydrogenolysis products of coals. K. Iwata, H. Itoh, K. Ouchi (Hokkaido University, Sapporo, Japan), and T. Yoshida (Government Industrial Development Laboratory, Sapporo, Japan). Fuel Processing Technology, vol. 3, Aug. 1980, p. 221-229. 11 refs. Research supported by the Iron and Steel Institute of Japan.

Three kinds of Japanese coal were hydrogenated under mild conditions in a stepwise manner to determine the precise coal structure. The total pyridine extraction yields of the products from the three coals were 58.0, 69.0, and 79.5%, respectively. The structural indices of these pyridine extracts show that, as the reaction proceeds, the structure becomes more aromatic and that lower-rank coals have a wider distribution of structural type. The average structural indices were compared with those obtained from the alcohol-alkali reaction products and quinoline extracts. The products of these three reactions gave nearly similar indices, although there was a slight difference. Tables illustrate the reaction condition and the pyridine extraction yield of hydrogenolysis products; analytical data of pyridine extracts of hydrogenation products; the results of structural analyses of pyridine extracts; and the comparison of the structural indices in various solubilization methods. S.S.

A80-49629 Qualitative and quantitative assessment of reaction models of coal hydrogenation. N. Nishida (Tokyo Science University, Tokyo, Japan), T. Chiba, and Y. Sanada (Hokkaido University, Sapporo, Japan). Fuel Processing Technology, vol. 3, Aug. 1980, p. 231-243. 9 refs.

In order to assess reaction models for coal hydrogenation, three reaction models were compared and their various parameter values were correlated by a set of experimental data obtained by previous investigators. These reaction models were then applied to a simulation model of a preheater-reactor system in order to study the effect of differences in the reaction models on the prediction of reactor performance. The results of the simulation have shown that substantial differences in the predicted values of coal conversion and yield of products were observed among the models. Finally, it was suggested that a suitable reaction model of coal liquefaction should be developed in the light of the future step of scale-up, simulation and optimization of coal-based commercial process systems.

(Author)

A80-49630 Selectivity improvement in the solvent refined coal process. I - Detailed first-stage reaction studies - Coal mineral catalysis. II - Detailed second-stage reaction studies - Hydrotreating of coal liquids. D. Garg, A. R. Tarrer, J. A. Guin, C. W. Curtis, and J. H. Clinton (Auburn University, Auburn, Ala.). Fuel Processing Technology, vol. 3, Aug. 1980, p. 245-261, 263-284. 17 refs. Contract No. DE-AC01-79ET-10554.

A two stage process is investigated for the production of a low-sulfur solid SRC-I (solvent refined coal) type boiler fuel with a minimum consumption of hydrogen. The first stage involves the scavenging action of coal minerals. Mineral additives (e.g., iron oxide and iron) increase selectivity for hydrodesulfurization over hydrogenation in coal liquefaction reactions. Mineral residues from SRC processes show insignificant desulfurization activity, but through oxidation, their sulfurization activity increases to significant levels without an increase in hydrogenation activity. The sulfur removal

activity of an additive depends on its surface area. The second stage involves hydrotreating the dissolver effluent for maximum sulfur removal, with a minimum consumption of hydrogen. The effect of a wide range of variables on hydrotreating of a coal liquid in the presence of a commercial Co-Mo-Al catalyst is evaluated. The variables include catalyst loading, hydrogen partial pressure, reaction temperature and time.

A80-49631 Production of light aromatics from coal hydrogenates. R. Cyprès and P. Bredael (Bruxelles, Université Libre, Brussels, Belgium). (IUPAC, CIC, and ACS, World Conference on Future Sources of Organic Raw Materials, Toronto, Canada, July 10-13, 1979.) Fuel Processing Technology, vol. 3, Aug. 1980, p. 297-311. 21 refs.

Results are presented for the pyrolysis of 1,2-dihydronaphthalene, perhydronaphthalene, and perhydroindan between 700 and 900 C at atmospheric pressure in a stream of nitrogen, with a residence time of 0.5 s in the reactor. The cracking of decalin, perhydronaphthalene, gives high yields (up to 30 percent by weight) of BTX, more than 20 percent ethylene and 15-20 percent methane. In contrast, the pyrolysis of 1,2-dihydronaphthalene or of tetralin, due to only partial hydrogenation of naphthalene, gives very small yields of benzene and other light aromatics. It has been shown that the complete hydrogenation of naphthalene makes it possible to break one of the two rings between 750 and 850 C and to produce simultaneously significant amounts of ethylene and light aromatics. The same phenomena have been observed in the pyrolysis of perhydroindan and other completely hydrogenated polyaromatic compounds. It can be concluded that complete hydrogenation causes the stability of the rings, which is characteristic of polyaromatics, to disappear. The industrial interest of the results obtained lies in the simultaneous production of light aromatics and ethylene from perhydropolyaromatic compounds formed by the hydrogenation of (Author) coal.

A80-49711 Comparison of alternate aviation fuels. E. N. Cart, Jr. (Exxon Research and Engineering Co., Florham Park, N.J.). Society of Automotive Engineers, International Air Transportation Meeting, Cincinnati, Ohio, May 20-22, 1980, Paper 800767. 9 p. 13 refs. Contract No. DE-AC05-77CSO-5438.

The paper examines properties, applications, and costs of future aircraft fuels. These fuels will be produced from shale or coal, liquid hydrogen (LH2) or liquid methane (LCH4). LH2 has a highest heat of combustion and specific heat, but low density and boiling point; it is also most expensive. For subsonic aircraft, shale oil distillates are most economical, followed by coal derived liquids and LCH4. The design advantages using LH2 are greater in supersonic than in subsonic aircraft; however, synthetic jet fuels from shale or coal are more attractive than LH2 on the basis of direct operating costs. An economic comparison shows the practicability of modifying engines to accept poorer quality fuel instead of upgrading their quality; a saving of \$440,000/yr/engine could be made if the engine can use a 10% hydrogen content fuel.

A80-49713 Future aviation fuels - The petroleum industry responds to the challenge. A. Lewis (Shell Research, Ltd., Thornton Research Centre, Chester, England). Society of Automotive Engineers, International Air Transportation Meeting, Cincinnati, Ohio, May 20-22, 1980, Paper 800769. 15 p. 15 refs. Research supported by the Department of Defence.

A review of future aviation fuel requirements and their specifications is presented. Refinery patterns tend to the production of distillate fuels at the expense of the heavier crude oil fractions; these distillates can be hydrogenated to produce the required products, but at a higher cost and low product yield. The effect of various hydrocarbon fractions and pure hydrocarbons on the combustion and low temperature properties of fuels and thermal stability were investigated. Finally, fuels derived from oil sands and shale oils are considered, along with the potential financial and supply problems of hydrogen for aircraft fuel treatment.

A80-49727 Efficiency of coal use, electricity for EVs versus synfuels for ICEs. H. G. Mueller (Gesellschaft für elektrischen Strassenverkehr mbH, Essen, West Germany) and V. Wouk (Victor Wouk Associates, New York, N.Y.). Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800109. 9 p. 15 refs.

Data are presented to show how electric vehicles will travel approximately twice as far per ton of coal burned to produce electricity for EV propulsion, than will an ICE vehicle burning the synfuel produced from an equal amount of coal. These figures are based on pessimistic calculations of the efficiencies of electricity generation, transmission, battery charging and EV drivetrains. The synfuel calculations are based on optimistic upper limits of coal conversion efficiency and ICE systems' efficiencies. EVs are less harmful to the environment than conventional vehicles. The emissions from coal-burning power plants are more readily controlled than the pollutants from refineries that convert coal to synfuel. The emissions from EVs are negligible, whereas those from ICEs still have not been reduced to the levels originally mandated for 1976. Synfuels should be reserved mainly for those applications for which electricity is impractical or impossible, such as planes, long-haul trucks and buses, and the petrochemical industry.

A80-49926 Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volumes 1 & 2. Congress sponsored by the World Health Organization, International Energy Agency, National Science Development Board of the Philippines, et al. Edited by K. J. Thome-Kozmiensky (Berlin, Technische Universität, Berlin, West Germany). Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979. Vol. 1, 767 p.; vol. 2, 719 p. In English, German, and French. \$81.40.

Trends of energy and material recycling are reviewed with attention given to such topics as refuse recovery systems, the regional planning of solid waste disposal plants, waste management in Germany, and solid waste management in Japan. Consideration is also given to the thermal processing of solid waste, the environmental impact of refuse-to-energy conversion, the incineration of municipal waste, biomass gasification processes, and the use of pyrolysis in waste disposal.

B.J.

A80-49927 Energy and material recycling. K. J. Thome-Kozmiensky (Berlin, Technische Universität, Berlin, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1-12. 11 refs.

Technical, economic, and ecological aspects of energy and material recycling are reviewed. Particular attention is given to the motor vehicle as an object of recycling, and the future outlook for material recycling is discussed.

B.J.

A80-49937 Status report on the research programme 'New processes of thermal waste treatment'. L. Barniske (Umweltbundesamt, Berlin, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1 Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 67-73.

The German thermal waste treatment program is reviewed. Attention is given to the gasification of domestic refuse and industrial wastes, the pyrolytic recovery of raw materials, the high-temperature combustion of wastes, the degassing of wastes in a rotary drum, and the degassing of used tires in a fluidized bed. B.J.

A80-49938 The conversion of refuse into energy within a regional context. G. A. Thomas (South Yorkshire County Council, Barnsley, Yorks., England). In: Recycling Berlin '79: Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 83-88.

The South Yorkshire Waste Reclamation Centre Project at Doncaster, England is described. The principal reclaimed materials are ferrous metals, waste derived fuel, paper as secondary fiber, and glass. The main features of the separation circuits and the separation center are presented.

B.J.

A80-49946 Potential for conversion of refuse to energy in Ontario Canada and the Provincial Energy from Waste program. R. M. R. Higgin (Ministry of Energy, Toronto, Canada). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 175-179. 8 refs.

A80-49948 Energy recovery from solid waste for city of Tehran. Z. Nejat (Teheran, University, Teheran, Iran). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p 189-194. Ministry of Energy of Iran Grant No. 2392/100.

Results of a comprehensive study of the sources, nature, and amount of the municipal solid waste of the city of Tehran are summarized. An average daily amount of collected solid waste is about 2250 t, with a mean calorific value of 1200 kcal/kg; the solid waste includes: food and garden waste (67.79%), paper, wood, and cardboard (17.228%), leather and cloth (4.052%), plastic and rubber (3.829%), glass (2.145%), metals (1.844%) and sand and dust (1.112%). The collection of used lubrication oils produced by public and private vehicles (150 cu m per day) also has been proposed. Based on the study, it has been decided to build a plant which would combine incineration with electrical power generation.

A80-49955 Refuse incineration - A recycling process. M. Rasmussen (Volund A/S, Glostrup, Denmark). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 289-300.

Waste has been utilized in Cophenhagen as an alternative source of energy for more than 50 years. Different aspects of waste utilization are discussed including corrosion in refuse incinerators and economic advantages of waste utilization (heating of homes, slabstone production from the residues). The operation of a plant which receives and processes domestic and industrial wastes from about 600,000 inhabitants is discussed, with emphasis on the main components of the furnaces. Application of residues (clinker) as base material in road construction is considered from the point of view of its possible influence on the environment (groundwater pollution).

S.S.

A80-49956 The combined firing of coal and waste derived fuel in steam raising plant. J. D. Tottman, K. Tittle, and B. Jones (Central Electricity Generating Board, Manchester, England). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 301-306.

A particular solution is proposed to the waste disposal problem in England. Waste is mixed with coal and burnt so that more than half of it is converted into two saleable products: energy for electrical generation and clinker. A process of waste working is described in a plant where oil waste is added to compost to enrich the 'fuel'. The mixing of domestic refuse and sludge is called Enriched Processed Refuse (EPR), and a system of producing a refuse derived fuel in combination with a combustible has been patented in the U.K. Problems of EPR storage and mixed fuel preparation are discussed as well as boiler efficiency using EPR/coal mixed fuel. Attention is drawn to the presence of zinc and lead in fuel dust, which requires more detailed consideration if large quantities of waste are to be burnt.

A80-49957 Co-combustion trials of pretreated solid urban refuse, on a brown coal-fired boiler. C. Rossi, G. Saccenti, and P. G. Tomei (Ente Nazionale per l'Energia Elettrica, Pisa, Italy). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-

Berlin, E. Freitag-Verlag für Umwelttechnik, Springer-Verlag, 1979, p. 307-311.

A80-49959 The combustion engineering approach to municipal solid waste energy recovery. M. L. Smith and H. von Steiger (Combustion Engineering, Inc., Windsor, Conn.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwerttechnik; Springer-Verlag, 19/9, p. 324-330.

Front-end processing that produces a good quality and easily combustible, but moderately priced fuel, is favored in solid waste resource recovery. The proposed system can be utilized to recover ferrous metals prior to mass burning. With the addition of other modules, it can also recover glass and aluminum, and it can prepare a fuel suitable for burning on a spreader stoker and a fuel for full suspension firing. The removal of ferrous scrap prior to incineration also reduces lead emissions. A 74 per cent process energy efficiency (conversion of energy potential in fuel to steam) and an 89 per cent total system efficiency are achieved.

A80-49962 The functional use of the heat generated by a refuse incineration plant as exemplified by the RIP Hamburg Stapelfeld. R. Calame (Widmer und Ernst AG, Wettingen, Switzerland). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 425-431.

A control boiler is used to reduce exhaust losses in the refuse incineration plant in Hamburg-Stapelfeld. The gas temperature at the input filter is also held constant over a long period of time. The heat generated by the boiler provides power needed by the plant. Heat is also used for low temperature heating of a greenhouse throughout the year, except for 13 days, when the outside temperature is below 5 C. Two options are offered to provide the additional heat, using the tap steam of a turbine or,an oil boiler. The energy requirements and costs are explored.

A80-49963 Waste handling Rijnmond - Energy production of a large-scale waste incineration plant. Z. A. Paroubek (Afvalverwerking Rijnmond, Rotterdam-Botlek, Netherlands). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 432-438.

The recovery of energy offers a market to handle the increasing amount of refuse, but large-scale incineration plants are required. The problems of transporting the refuse and destroying wastes (preferably in smaller incineration plants) have worked against a system of large scale plants. The Afvalverwerkung Rijnmond (AVR), located near Rotterdam, and one of the largest refuse incineration plants in the world, serves as the model for discussion. After meeting its own needs, the plant supplies the surplus electric power to the public system. A water factory which uses the low pressure steam from the back pressure turbines produces high quality distilled water. A net power supply of 145 million kW was provided in 1979, along with 6.1 million tons of water. Out of the energy supplied in the form of waste, 32 percent is given back in a usable form. The efficiency approaches the value of slightly older electric power stations. The transport operations for supplying the plant with waste material are presented.

A80-49964 A refuse incineration plant in combination with district heating demonstrated by the Iserlohn Plant. H. Schmidt. In: Recycling Berlin '79; Proceedings of the International Congress,

Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 439-443.

A80-49965 Combined production of electrical energy and heat in municipal refuse incinerators in the greater Paris area. P. Passelergue (Electricité de France, Paris, France). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 444-449. In French.

A80-49966 Services rendered for waste incineration power plants technology and implementation exemplified with the waste incineration heating power plant of the seaport of Bremerhaven. H. Konwiarz (Neue Heimat Kommunal, Hamburg, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer Verlag, 1979, p. 450-456.

A80-49974 The potential in Denmark for substituting natural resources by waste incineration products. S. D. Pedersen (Vandkvalitetsinstituttet, Horsholm, Denmark). In: Recycling Berlin 79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 528-532. 9 refs.

The potential reuse of waste incineration products (heat, cinders and fly ash) to substitute for natural resources such as oil, coal (heat generation), gravel, and sand is considered. The heat of combustion generated by the total amount of incinerated wastes in Denmark can be substituted for an equivalent quantity of oil corresponding to 2.5-3% of the nation's consumption of oil for heating. A 5% substitution of gravel by incineration cinders is foreseen. A.C.W.

A80-49978 Biomass gasification processes. J.-F. Molle (Centre National d'Etudes et d'Expérimentation de Machinisme Agricole, Antony, Hauts-de-Seine, France). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 581-587. In French.

The paper describes high-temperature gasification of forestry and agricultural waste. The process operates at 1000 C, producing gas with an energy content of 1000-1200 kcal/N cu m at an overall efficiency of 80 percent. A synthesis gas containing CO and H2 in a 1:1 ratio can be produced using oxygen as a gasification medium. Six million tons of forestry waste and nine million tons of agricultural biomass are available yearly in France as raw materials for gasification.

A.T.

A80-49979 The gasification of municipal and industrial waste in accordance with the SFW-FUNK-Process. F. Heinrich (Saarberg-Fernwarme GmbH, Saarbrücken, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 588 594.

A process by which a usable gas is produced from solid waste has been tested for its practical application in both a small pilot plant and a large demonstration plant. This gasification process combines the partial oxidation and pyrolysis of municipal and industrial waste with an efficient gas purification and separation method. The data obtained from test trials are given including the composition of gas, the values for rate and volume of gas production, maximum input of solid waste, and length of continuous plant operation periods. From test results, it is judged that there is good potential for the commercial application of this gasification process.

A.C.W.

A80-49981 Recent developments in a slagging process for conversion of refuse to energy. S. D. Mark, Jr. (Andco, Inc., Buffalo, N.Y.), D. Bohn (Antox GmbH, Ingbert, West Germany), and C. Melan (Paul Wurth, S.A., Luxembourg). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 601-608. 9 refs.

The status of the Andco-Torrax system (ATS), a slagging process for converting municipal solid waste (MSW) to energy and an inert glassy aggregate residue is reviewed. The main technical problems which were encountered and resolved in various plants are cited. Calculations of heat and mass balances and estimates of capital and operating costs for ATS plants are given. Two applications of ATS which involve a co-disposal of MSW and other waste material are described along with two proposals for the adaptation of ATS to the cement-making process and to the management of nuclear waste.

A.C.W.

A80-49982 Integrated system for solid waste disposal with energy recovery and volumetric reduction by new pyrolysis furnace. T. Mori (Hitachi Shipbuilding and Engineering Co., Osaka, Japan). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1:

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 609-614.

A80-49983 Kiener pyrolysis, a link between waste disposal and energy supply. S. Lenz (Gesellschaft für thermische Abfallverwertung mbH, Stuttgart, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 1. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 640-645.

The use of the Kiener pyrolysis process for municipal waste disposal and energy production is discussed with reference to a Kiener plant designed for a locality with a population of 120,000. The plant which transforms the heat content of the waste into power can produce 21 million kWh with an installed electrical capacity of just under 3000 kW in 7000 operation hours; the effective power of the plant is about 130,000 GJ/A. The plant is environmentally safe and saves 7000 tons of oil annually.

V.L.

A80-49989 Possibilities of high temperature waste incineration with the FLK-process. H. P. Schmidt. In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 737-743. 11 refs.

The FLK process for high-temperature waste incineration is presented and its advantages are pointed out. The FLK furnace consists of two concentric cones beneath which the flame chamber is formed by the waste itself, and process reactions and conditions which allow the separation of waste decomposition from hightemperature combustion. The process is capable of treating any kind of waste as long as it is reduced to the proper size, requires a very low excess air rate and allows a reduction in flue gas emissions. In addition, operating conditions including the complete burn-up of flue gases decrease the necessity of a large-capacity afterburning chamber, reduce the heavy-metal content of the emission gas, maximize the efficiency and operational readiness of heat recovery, improve material recovery, and allow the construction of an apparatus at low cost. Present applications include the treatment of industrial solid wastes, paint residues and waste water, dehydrated sewage sludge and low-radioactive solid wastes at a nuclear plant.

A.L.W.

A80-49991 Plants for energy and material recycling. H. J. Giese (Abfalltechnik Fröhling-Siegofa, Overath, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress. Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 750-755. 11 refs. In German.

The development of incineration plants by the Fröhling Company over a period of twenty years is discussed. The plants range in performance between 200 and 1,000 kg/hr of refuse. The reclamation of energy from the refuse is stressed along with the recycling of useable materials. The Pyro-reactor, which reduces gas exhaust, is described.

A80-49994 Biogas from residues of animal husbandry and agricultural plant production. W. Baader (Bundesforschungsanstalt für Landwirtschaft, Institut für Landmaschinenforschung, Braunschweig, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 774-778. 5 refs.

A80-4995 Recycling of effluents and organic residues into methane by anaerobic digestion - New perspectives. H. P. Naveau (Louvain, Université Catholique, Louvain-la-Neuve, Belgium), E. J. Nyns, R. Binot, and M. Delafontaine. In: Recycling Berlin 79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 783-788. 16 refs.

A80-49996 The production of substitute natural gas and recyclables from municipal solid waste. S. Ghosh and D. L. Klass (Institute of Gas Technology, Chicago, III.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 789-796. 10 refs. Research supported by the Citizens Gas and Coke Utility and Institute of Gas Technology.

The BIOGAS process being developed by the Institute of Gas Technology is discussed in terms of conceptual process design, material and energy balance, and process economics. The process consists of a series of physical, chemical, and biological operations for separation of raw municipal solid waste into organic and recyclable inorganic materials; blending of the organic fraction with primary-activated sludge; conversion of the blend to pipeline quality (1000 Btu/SCF) or medium-Btu (600-800 Btu/SCF) gas and stabilized solid residue; and finally, treatment of the liquid effluent for discharge. Analysis for a 2000-ton/day plant shows a DCF rate of return of 26.8% on equity and 11.5% on total investment for a 20-year period of operation.

A80-49997 Biogasification of municipal waste. M. Ishida, Y. Odawara, T. Gejo, and H. Okumura (Hitachi, Ltd., Hitachi Research Laboratory, Hitachi, Ibaraki, Japan). In: Recycling Berlin 79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, 797-802. Research supported by the Agency of Industrial Science and Technology of Japan.

An advanced biogasification process has been developed which treats a mixed slurry of the garbage fraction of municipal refuse and sewage sludge with recovery of methane. The process consists of three stages: heat treatment under alkaline conditions, liquefaction fermentation, and gasification termentation. It is shown that in comparison to conventional processes, the proposed process has the shortest fermentation time and the highest methane yield and concentration even at higher loading. The operation of a pilot plant is discussed.

A80-49998 The Wetox process for energy recovery from sewage sludge and industrial waste streams. R. G. W. Laughlin and A. P. Cadotte (Ontario Research Foundation, Mississauga, Ontario, Canada). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 803-809.

A80-49999 Use of gas from landfills for energy recovery-Operating experience at Palos Verdes. R. K. Ham (Wisconsin, University, Madison, Wis.) and R. H. Collins, III (Reserve Synthetic Fuels, Inc., Signal Hill, Calif.). In: Recycling Berlin 79; Proceedings of the International Congress, Berlin, West Germany, October 1:3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 810-815.

A80-50000 Methane production from urban solid wastes.
R. F. Aller (ENADIMSA, Madrid, Spain). In: Recycling Berlin '79;
Proceedings of the International Congress, Berlin, West Germany,
October 1-3, 1979. Volume 2. Berlin, E. FreitagVerlag für Umwelttechnik; Springer-Verlag, 1979, p. 816-822.

The application of an anaerobic digestion process to the treatment of organic matter contained in urban solid waste to produce methane is discussed with emphasis on process optimization and economic analysis. The process consists basically of a two-stage breakdown of organic matter in an anaerobic atmosphere: (1) liquefaction and hydrolysis, and (2) fermentation and gasification. Results of two-year bench-scale experiments are analyzed.

A80-50005 Economic and technical evaluation of the Ames, Iowa solid waste recovery system. A. W. Joensen, J. Even, J. L. Hall, D. Van Meter (Iowa State University of Science and Technology, Ames, Iowa), and R. Olexsey (U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Cincinnati, Ohio). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 903-908. Research supported by the U.S. Economic Development Agency and U.S. Department of Energy.

The City of Ames, Iowa has been commercially operating a solid waste recovery system since November, 1975. This system processes municipal and commercial solid waste to recover refuse derived fuel (RDF) and ferrous metals. The RDF is fired with Iowa-Western coal mixtures in the municipal power plant and recovered metals are sold for scrap. This paper presents summary data from a research evaluation program funded by the Environmental Protection Agency and from a laboratory analysis by the Department of Energy.

(Author)

A80-50008 Energy recycling through refuse pelletizing. F. J. Wyss (Gebr. Bühler AG, Uzwil, Switzerland). In: Recycling Berlin 79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 952-957.

The Bühler Compo+Pell process is a refuse-recycling system combining the production of both compost and fuel. The high-calorific-value components are separated from prereduced municipal waste by means of conventional techniques, i.e., screening and air classification, and are converted into refuse-derived-fuel pellets. Such pellets can be utilized for normal industrial firing systems. (Author)

A80-50009 Combustible briquets from waste using the PINEDA/LOAS process. R. J. Jonke (Agence Nationale de Valorisation de la Recherche, Neuilly-sur-Seine, Hauts-de-Seine, France). In: Recycling Berlin '79: Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 958-962.

The PINEDA/LOAS process combines the mechanical process of mincing organic matter with its fermentation, i.e., the decomposition of material is carried out both by mechanical and biological means. The drying process consumes less power than with known processes by using heat generated during fermentation, no binder has to be added to compressed material as lignin contained in the cellular tissue acts as a binder during compression, and moulding pressures and temperatures are lower than in other processes. The process is illustrated by an example involving the processing of purely vegetable

waste. The operation of a pilot plant and applications of solid compact fuel from organic wastes are discussed.

A80-50010 Chemical fuel and raw material production by thermal processing of refuse - Technology and economics. A. V. Bridgwater, B. W. Hatt (Aston, University, Birmingham, England), and G. Ader (Ader Associates, West Wickham, Kent, England). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 963-968.

An economic analysis is carried out for thermal conversion of refuse into methanol. A special cost model has been derived by analysis of 38 different costs and cost estimates for 8 different thermal processes and cost equations have been obtained by regression analysis on normalized actual and estimated costs. It is shown that if the criterion for economic viability is comparison with the cost of methanol produced via conventional chemical processes, then a minimum facility size of about 750 t/d dry raw refuse is necessary together with reasonably efficient front end and back end processes.

V.L.

A80-50011 Refuse to fuels - An appraisal of thermal processes. B. W. Hatt, A. V. Bridgwater (Aston, University, Birmingham, England), and G. Ader (Ader Associates, West Wickham, Kent, England). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 969-974.

Developments in the field of thermal conversion of organic waste into fuels are discussed with reference to the results of a survey into existing and proposed processes. Basic thermal process routes are identified, including such processes as pyrolysis, gasification, hydrogenation, hydrogasification, and steam reforming. Consideration is given to thermal reactors and variables determine the predominant reactions as well as the nature and yield of the final product. Finally, several criteria by which thermal processes may be compared and evaluated are suggested.

A80-50017 Brini - A completion to solid fuels. B. Enhorning (VIAK AB, Stockholm, Sweden). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1262-1270.

The Brini compacting process has been developed for the treatment and disposal of solid wastes. The characteristics of the Brini process are described, and attention is given to the associated pollution.

A80-50018 Co-firing densified refuse derived fuel in a spreader stoker fired boiler. G. H. Degler and C. C. Wiles. In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1271-1276.

As a resource recovery alternative, the use of refuse-derived fuel (dRDF) is being investigated as a substitute for coal in industrial spreader stoker boilers. Experiences are summarized from the combustion testing of 1/2-inch-diameter pellets using a modified animal pellet mill. Storage and handling experiences are also discussed. Approximately 1800 MG of dRDF have been burned in a spreader stoker equipped boiler. The first phase of the combustion tests involved an evaluation of boiler performance and emission when firing at coal:dRDF blends of 1:0, 1:1, 1:2, and 0:1. A total 245 Mg of 1/2-inch-diameter by 3/4-inch-long pellets were consumed during these tests. The second phase of the combustion tests involved the combustion of 1555 Mg of pellets. (Author)

A80-50019 Fluidized bed combustion of refuse derived fuels. K. W. Ragland and D. B. Paul (Wisconsin, University, Madison, Wis.). In: Recycling Berlin '79; Proceedings of the International

Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.
Berlin, E. Freitag-Verlag für Umwelttechnik;
Springer-Verlag, 1979, p. 1277-1281. 15 refs.

The findings of laboratory tests in which refuse derived fuel (RDF) and polyvinyl chloride (PVC) waste material were burned in a 0.3 m diameter fluidized bed combustor using limestone and silica sand are presented. Adequate mixing of the RDF throughout the bed was achieved by using a small bed particle size (2.36-0.85 mm for limestone and 0.6-0.5 mm for silica sand) and a superficial velocity in the bed well above that required for minimum fluidization. The ignition temperature for the RDF tested was 370 C; in a practical system it would be 850-950 C. At these temperatures, hydrogen chloride gas released from the combustion of PVC is readily absorbed by a limestone (dolomite) bed.

A80-50020 Refuse/sludge/hazardous waste co-disposal with energy recovery. J. W. Smith, M. C. Stiles, and J. A. Hayden. In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1289-1295.

The U.S. EPA funded codisposal project which is being implemented by the City of Memphis is discussed with emphasis on the planning and implementation aspects as well as some technical and economic details. The system entails the complete combustion of wastewater treatment plant sludge and industrial/flammable wastes with the use of energy from refuse in an environmentally sound technology. The co-combustion of wastes and sludge in an energy recovery center will be used to generate steam for industrial use. Excess refuse derived fuel (RDF) will be fired in spreader stoker waterwall incinerators with coal to provide backup and peaking steam requirements. The value of the RDF generated steam is set at 3.78 dollars per million BTU which is competitive with the cost of energy from oil or coal.

A80-50024 A method to reclaim metallic material and energy from automobiles. W. C. Dries (Wisconsin, University, Madison, Wis.). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2.

Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1316-1321. 13 refs.

An energy self-sufficient automotive scrap recycling process is proposed which employs the incineration of combustible components (paper, fabric, rubber, and petroleum products) to produce heat, steam, and electric power. An air separation plant is used to produce liquid nitrogen and liquid oxygen. The nitrogen is used to cool auto hulks before processing which makes it possible to reduce the shredder horsepower by 75-80%. The oxygen is used to enhance the combustion process in the steam boiler of a turbine generator and to eliminate air pollution due to incomplete combustion. Estimates of the capital and operating costs, annual income, and gross profit are presented for a plant to produce 100,000 tons of shredded ferrous scrap, 3113 tons nonferrous, and 6000 tons oxygen per year.

A80-50032 Waste oil as a fuel. W. Kroll (Walter Kroll GmbH, Kirchberg am Murr, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1368-1373

The potential of waste oil from motors, turbines, transmissions and other industrial sources as a heating fuel is examined. Possibilities for the reutilization of waste oil are considered, and problems associated with second refining and the combustion of waste oil to generate heat in large-scale plants are pointed out. The principles of waste oil furnaces for use in small-scale plants for the generation of heat for small and medium-sized businesses are outlined, and the savings in fuel oil and disposal costs brought about by waste oil incineration are pointed out. Consideration is given to the levels of emissions from waste oil furnaces and applications of the furnaces in

the area of material recycling. It is concluded that waste oil definitely has a future as a fuel and this use can represent a partial solution to the problem of waste oil disposal.

A.L.W.

A80-50033 Why new technology to rerefine waste lubricating oil. R. Havemann and C. Lafrenz (Haberland und Co., Dollbergen, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik: Springer-Verlag, 1979, p. 1374-1381. 6 refs.

The paper surveys waste oil re-refining in Germany and examines the specific problems which re-refining has in common with other recycling activity. Particular attention is given to the KTI process, which involves the high-vacuum distillation of the waste oil and distillate finishing by hydrogenation.

A80-50034 New directions in energy recovery from petroleum refinery oily sludges. G. Engel (Oil Refineries, Ltd., Haifa, Israel). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1388-1393. 12 refs.

A80-50036 Fuel gas from used tyres by means of the Babcock-Rohrbach process. H. Wefing and R. Noack (Deutsche Babcock und Wilcox AG, Oberhausen, West Germany). In: Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volume 2. Berlin, E. Freitag-Verlag für Umwelttechnik; Springer-Verlag, 1979, p. 1413-1418.

A80-50278 D.C. electrical conductivity of Green River oil shales. K. Rajeshwar, M. Das, and J. DuBow (Colorado State University, Fort Collins, Colo.). *Nature*, vol. 287, Sept. 11, 1980, p. 131-133. 8 refs. Research supported by the U.S. Department of Energy.

Direct-current conductivity measurements have been carried out on Green River oil shales in the temperature range of 25-500 C. The observed electrical behavior of this material is found to be consistent with a two-step decomposition model in which the rate-determining processes are: (1) breakdown of an outershell polar bridge structure with an activation energy of 15 plus or minus 2 kcal/mol (180-350 C) and (2) cleavage of an inner core naphthenic structure also involving polar groups with an activation energy of 35 plus or minus 3 kcal/mol (350-500 C). These structural changes correspond to the chemical transformation of kerogen to liquid and gaseous hydrocarbons through a bitumen intermediate.

A80-50814 Strategies for rational utilization of bituminous coal deposits in the German Federal Republic (Strategien zur rationellen Nutzung der Steinkohlenlagerstätten in der Bundesrepublik Deutschland). F. C. Erasmus (Ruhrkohle AG, Essen, West Germany) and R. Lenhartz (Saarbergwerke AG, Saarbrücken, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 349-355. In German.

The status and economic conditions for coal mining in the GFR are examined, and the production of the individual coal regions is reviewed. Exploratory work, conducted in the light of inevitable production increases in the future, is noted. Some changes in the present coal production and utilization strategies which may be needed to meet future requirements and at the same time optimize the mining procedures are discussed.

V.P.

A80-50815 Power generation from municipal and industrial wastes with particular reference to sewage combustion (Energiegewinnung aus kommunalen und industriellen Abfällen unter besonderer Berücksichtigung der Klärschlammverbrennung). B. Braun (Vereinigte Kesselwerke AG, Düsseldorf, West Germany) and H. Lauer (Badische Anilin- und Soda-Fabrik AG, Ludwigshafen am Rhein, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 355-359. In German.

Some characteristic features and modern technological concepts employed in large sewage combustion plants are examined. Particular attention is given to the plants in Krefeld, Wuppertal, and Ludwigshafen, Germany, and in Ajinomoto, Japan.

V.P.

A80-50817 Potentialities and limitations of future use of coal for power generation (Möglichkeiten und Grenzen des zukünftigen Einsatzes von Kohle in der Energieversorgung). W. Peters (Bergbau-Forschung GmbH, Essen, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 367-372. 17 refs. In German.

The current status of coal gasification and liquefaction processes is reviewed, and the principles of the Lurgi pressure gasification method, the Shell-Koppers pressure gasification process, and the Saarberg-Otto gasification process are examined. Some features of the fluidized bed process (under development) are discussed.

A80-50823 The usefulness of 'alternative' energy sources from the economic and energetic point of view (Zur Nutzbarkeit 'alternativer' Energiequellen aus wirtschaftlicher und energetischer Sicht). U. LaRoche (Brown, Boveri et Cie, Raden, Switzerland) and U. Möller (Brown, Bovery et Cie, AG, Mannheim, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Sept. 1980, p. 405-409. 11 refs. In German.

In the present paper, a factor expressing the direct relationship to the environment via an energy balance is introduced and is used as a basis to study the energy sources that are suitable as substitutions for fossil fuels from the energy point of view. Particular attention is given to nuclear energy and hydraulic power.

V.P.

A80-50880 Landsat imagery in oil exploration - Six years of experience (Les images Landsat en exploration pétrolière - 6 ans d'expérience). A. Fontanel and J.-C. Riverau (Institut Français du Pétrole, Rueil-Malmaison, Hauts-de-Seine, France). In: Cartographic processing and analysis of satellite imagery; International Conference, 3rd, Toulouse, France, June 19-22, 1979, Proceedings.

Saint-Etienne, Loire, France, Edition Gedim, 1980, p. 27-30. In French.

A review of the most common utilizations of Landsat images in geological and petroleum studies is presented. Included in the report are characteristics of the geological surveys such as scale, percentage and type of color compositions, and type of digital processing. The cost of the surveys and various financial constraints of digital processing are also presented.

A.C.W.

A80-50908 Use of geothermal energy in the eastern United States. F. C. Paddison and K. Yu (Johns Hopkins University, Laurel, Md.). Johns Hopkins APL Technical Digest, vol. 1, Apr. June 1980, p. 88-100. 37 refs. Research sponsored by the U.S. Department of Energy.

This article discusses the location of potential geothermal resources in the eastern United States, where the only confirmed hydrothermal field is located on the edge of the Delmarva Peninsula. The manner and economics of the field's use to heat a high school in Crisfield, Md., the pros and cons of extending the use of the resource to community heating, and institutional considerations are also discussed. It is concluded that the use of hydrothermal resources with greater than normal thermal gradients in the eastern United States appears promising if system design is optimized and capital costs are minimized. (Author)

A80-50963 # The utilisation of oil shale and lignite as low grade fuels in a cyclone furnace. K. Silapabanleng (Chulalongkorn University, Bangkok, Thailand). Regional Journal of Energy, Heat and Mass Transfer, vol. 1, Dec. 1978, p. 15-19. 8 refs. Research supported by the National Energy Authority of Thailand.

Oil shale and lignite have been successfully used as low-grade fuel in a vertical cyclone furnace of 35.56 cm diameter. The

combustion intensities calculated at blowout are 990,500 Kcal/hr per cubic meter for oil shale and 710,200 Kcal/hr per cubic meter for lignite, as compared to 934.5 Kcal/hr per cubic meter for saw dust used in a horizontal cyclone furnace of 30.5 cm diameter. However, prolonged combustion is not possible at this stage as the sticky molten slag formed during combustion gradually reduces the effective heated area of the furnace, and ignition of fresh charge becomes impossible.

A80-51076 Remote sensing and mineral exploration; Proceedings of the Workshop, Bangalore, India, May 29-June 9, 1979. Workshop sponsored by COSPAR, International Union of Geological Sciences, UNESCO, Geological Survey of India, et al. Edited by W. D. Carter, L. C. Rowan (U.S. Geological Survey, Reston, Va.) and J. F. Huntington (Commonwealth Scientific and Industrial Research Organization, North Rhyde, Australia). Oxford, Pergamon Press, Ltd. (Advances in Space Exploration. Volume 10), 1980. 182 p. \$60.

Papers presented in this volume reflect the international state-of-the-art of remote sensing in the field of geology and exploration for mineral and energy resources. The papers include: contribution of Landsat data to the objectives of the geological survey of India; mineral resource exploration, inventory, and assessment; geological ground-truths and Landsat imagery interpretation for parts of Karnataka State (India); and the application of remote sensing techniques to petroleum exploration in India. V.L.

A80-51088 Application of remote sensing techniques to petroleum exploration in India. S. N. Talukdar (Oil and Natural Gas Commission, Institute of Petroleum Exploration, Dehra Dun, India). In: Remote sensing and mineral exploration; Proceedings of the Workshop, Bangalore, India, May 29-June 9, 1979.

Oxford, Pergamon Press, Ltd., 1980, p. 121-126.

The extensive use of remote sensing techniques in petroleum exploration in India had a modest beginning in 1930s when the geologists of Assam Oil Company employed photogeological methods to map the densely forested, and highly inaccessible areas in Assam, Tripura and Mizoram in the eastern part of India. After the 'Oil and Natural Gas Commission' was set up in 1956, to explore for petroleum in India, photogeological and photogeomorphological studies were extended to cover all the sedimentary basins of interest in India. With the availability of Landsat data, both visual and machine aided interpretation techniques have greatly facilitated the oil exploration efforts. An outline of the activities of Oil and Natural Gas Commission in this fascinating field is presented in this 'paper.

(Author)

A80-51210 Thermodynamic analysis of coal gasification processes. S. P. Singh, S. A. Weil, and S. P. Babu (Institute of Gas Technology, Chicago, III.). (U.S. Department of Energy, Workshop on the Second Law Analysis of Energy Devices and Processes, Washington, D.C., Aug. 14-16, 1979.) Energy (UK), vol. 5, Aug. Sept. 1980, p. 905-914. 20 refs. Contract No. ET-78-C-01-2806.

Thermodynamic analysis for evaluating and improving coal gasification process efficiency requires estimation of enthalpy, entropy, and availability transformations in various process steps. A compilation of procedures and data relevant to coal gasification processes is presented for calculating the above thermodynamic properties. Enthalpy and availability transformations are estimated for significant process steps in the HYGAS process for producing substitute natural gas from coal. The thermal efficiencies based on the first law of thermodynamics are compared with the availability efficiencies based on the second law. Work intensive process steps, such as gas compression and separation, are shown to have extremely low thermal efficiencies and fairly high availability efficiencies. Heat intensive process steps, such as steam generation, have high thermal efficiencies but generally poor availability efficiencies. (Author)

A80-51498 The technical and economic aspects of brown coal refinement (Technische und wirtschaftliche Gesichtspunkte der Braunkohleveredlung). P. Speich (Rheinische Braunkohlenwerke AG,

Cologne, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Aug. 1980, p. 307-312. In German.

The use of coal to fulfill energy needs is considered and the expanded use of nuclear power for generating electricity is taken into account. Production of synthesis gas, natural gas, and fluid products from coal is discussed. Statistics on energy use are provided along with the costs of coal by-products relative to oil and natural gas. R.C.

A80-51499 The use of refuse heat assisted by heat transformers (Nutzung von Abfallwärme mit Hilfe von Wärmetransformatoren). C. Mostofizadeh (Fried. Krupp GmbH, Forschungsinstitut, Essen, West Germany). Brennstoff-Wärme-Kraft, vol. 32, Aug. 1980, p. 312-316. In German.

The principle of heat transformation from lower temperatures to higher temperatures is investigated. The heat transformer works like an absorption refrigerator and can increase the temperature by 30 K. A testing plant was set up, and measurements show the utility of heat transformers. The construction and mode of operation of the heat transformer are described.

A80-51571 Global model of countercurrent coal gasifiers. P. G. Kosky and J. K. Floess (GE Research and Development Center, Schenectady, N.Y.). I & EC - Industrial and Engineering Chemistry, Process Design and Development, vol. 19, Oct. 1980, p. 586-592. 27 refs.

This is a model of a fixed-bed coal gasifier in which CO, CO2, H2O and H2 are assumed to be in thermodynamic shift equilibrium over a zone in which the primary gasification reactions occur. Exiting temperatures from this zone are in excess of 550 C and the shift reaction is readily catalyzed by gas-borne impurities. Fresh coal is pyrolyzed in this gas stream and its gaseous products are added quantitatively to the shift gases. The final raw product gases thus calculated are close to experimental data from several sources for oxygen- and air-blown gasifiers. The model, which is simple conceptually and mathematically, correctly predicts the effect of heat leak in establishing the composition of the raw coal gas from a fixed bed gasifier. This important variable has not had the visibility that its significance demands. (Author)

A80-51953

Alcohol fuels for spaceship earth. V. D. Hunt (TRW Energy Systems Group, McLean, Va.). In: A new era in technology; Proceedings of the Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980.

Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, p. 6-53 to 6-58.

Alcohol fuels are discussed with particular reference to gasonol, a blend of 10% agriculturally derived anhydrous ethanol and 90% unleaded gasoline. The ethanol production process, effective feed-stocks, and typical plant design are examined. Consideration is also given to federal programs concerned with alcohol fuels and economic impact of ethanol production.

A80-52049 # Thermodynamic and economic analysis of heat pumps for energy, recovery in industrial processes. A. H. Urdaneta-B and P. S. Schmidt (Texas, University, Austin, Tex.). (American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec. 10-15, 1978, Paper 78-WA/HT-64.) ASME, Transactions, Journal of Energy Resources Technology, vol. 102, Sept. 1980, p. 173-180. 13 refs.

A computer code has been developed for analyzing the thermodynamic performance, cost and economic return for heat pump applications in industrial heat recovery. Starting with basic defining characteristics of the waste heat stream and the desired heat sink, the algorithm first evaluates the potential for conventional heat recovery with heat exchangers, and if applicable, sizes the exchanger. A heat pump system is then designed to process the residual heating and cooling requirements of the streams. In configuring the heat pump, the program searches a number of parameters, including condenser temperature, evaporator temperature, and condenser and evaporator approaches. All system components are sized for each set of parameters, and economic return is estimated and compared with system economics for conventional processing of the heated and

cooled streams (i.e., with process heaters and coolers). Two case studies are evaluated, one in a food processing application and the other in an oil refinery unit. (Author)

A80-52851 Biomass for energy. London, International Solar Energy Society, 1979. 100 p. A80-52852 to A80-52859)

The conference concentrated on technical, economic, environmental, and social aspects of energy production from biomass. Papers are presented on wood fuel production experiments in Sweden; the Brazilian National Alcohol Program; research, development, and commercialization activities on biomass energy in the United States; and the European Community's biomass program.

V.L.

A80-52852 World biomass - An overview. D. O. Hall (King's College, London, England). In: Biomass for energy.

London, International Solar Energy Society, 1979, p. 1-14. 40 refs.

Research and development programs on biomass carried out in various countries of the world are reviewed with reference to biomass conversion processes and products and energy from biomass predicted production costs. Advantages and problems associated with biomass energy systems are summarized, and recommendations for further development are given, including more efficient use of existing biofuels, increased residue and complete crop utilization, energy farming, improved plant species, and artificial photobiology and photochemistry.

A80-52853

Programme
Biofuels. G. H. King (Atomic Energy Research Establishment, Harwell, Oxon, England). In: Biomass for energy.
London, International Solar Energy Society,

1979, p. 15-25.

Assessment studies have been conducted by the UK Department of Energy with a view to defining a research and development program in biofuels. Some of the important findings of the first year's work are: organic wastes having no economic value are equivalent to 7% of the UK's current energy requirement; methanol (by pyrolysis) and methane (by anaerobic digestion) could be produced at competitive prices in large-scale conversion plants; and the use of some biofuels is already economical, since their production costs are effectively subsidized by waste disposal. Guidelines for further studies are outlined.

A80-52854 Wood fuel production experiments in Sweden.
G. Siren (Sveriges Lantbruksuniversitet, Uppsala, Sweden). In:
Biomass for energy.
Energy Society, 1979, p. 26-29.

Field experiments in energy forestry are reviewed with reference to the species selection and production options, stand establishment, ecophysiological optimization of production conditions, environmental consequences, energy balance, and socio-economic implications. Energy input-output analysis indicates that well planned intensive energy forestry will result in a ratio better than 10:1 in favor of output.

V.L.

A80-52855 The Brazilian National Alcohol Programme. I. Gochnarg (Instituto de Pesquisas Tecnológicas, São Paulo, Brazil). In: Biomass for energy.

London, International Solar Energy Society, 1979, p. 30-50. 51 refs.

The National Alcohol Program of Brazil is discussed with respect to its objectives, problems associated with alcohol production, distribution, and utilization, its economic feasibility, and social significance. The main goal of the program is to reduce imported crude oil bill by blending gasoline with up to 20 percent by volume of agriculturally derived ethyl alcohol. It is expected that the admixture of ethanol, combined with changes in oil refinery operations, will result in savings of close to 650 million dollars per year in the cost of imported crude. It is also shown that the program will result in indirect benefits such as increase in employment opportunities, reduction in regional and individual income discrepan-

cies, expansion of capital goods production, and improvement of national technology in agricultural and industrial sectors.

A80-52856 Canadian biomass perspective - A new interest in an old fuel. J. E. Marshall (Department of the Environment, Ottawa, Canada). In: Biomass for energy.

London, International Solar Energy Society, 1979, p. 51-60. 6 refs.

A liquid fuels feasibility study has been conducted in Canada in order to evaluate the extent of Canadian renewable liquid fuels development between 1985 and 2025 as well as institutional frameworks and strategies for the development of large-volume fuel production from the renewable resources. Results of analysis are presented for three sources of potential biomass supply: forest biomass, agricultural biomass, and municipal solid wastes.

A80-52857 Research, development, and commercialization activities on biomass energy in the United States. D. L. Klass (Institute of Gas Technology, Chicago, III.). In: Biomass for energy.

London, International Solar Energy Society, 1979, p. 61-68.

Research and development activities in the U.S. on the production of energy products and synthetic fuels from organic wastes and land- and water-based biomass are growing rapidly. Commercialization of the results of this effort is also progressing but at a lower rate. Commercial plants are currently operating to produce steam and electric power by combustion or co-combustion of municipal solid wastes, agricultural residues, and wood; methane from landfills and cattle manure; and fermentation alcohol for use in gasohol blends. Available fossil fuels are still sufficiently low in cost in the United States to make the economics of producing substitute fuels from biomass borderline or unattractive. Large-scale integrated biomass energy systems are therefore not expected to be constructed and operated until the late 1980s and early 1990s. Nevertheless, about 2.1% of the U.S. total energy supply is now derived from biomass; this corresponds to about 1.7 x 10 to the 15th Btu.

(Author)

A80-52858

Biomass - Future developments. J. Coombs and K. J. Parker (Tate and Lyle, Ltd., Reading, Berks., England). In: Biomass for energy.

London, International Solar Energy Society, 1979, p. 69-89. 40 refs.

Prospects for biomass conversion and utilization around the world are analyzed with reference to various biomass sources and conversion technologies. Particular consideration is given to the use of carbohydrates as chemical feedstock and the development of integrated energy systems based on sugar cane for the production of liquid fuels. Some problems are discussed, such as those arising from the diffuse nature, low energy density, and high water content of biomass; competition for water, land, and plant material with food, urban, or amenity use; and the high cost of setting up completely new, large-scale agricultural and processing schemes.

V.L.

A80-52859. European Community's biomass programme.
P. Chartier (Institut National de la Recherche Agronomique, Versailles, France). In: Biomass for energy. London, International Solar Energy Society, 1979, p. 90-99.

Results of the first four-year program of the European Community on energy from biomass are briefly summarized. The discussion focuses on the following projects: (1) use of straw as an energy feedstock on and off the farm; (2) forestry products, wood wastes, and short rotation forestry as biomass resources for energy purposes; (3) algal energy production systems; (4) gasification of wood, straw, and other agricultural residues; and (5) anaerobic digestion for animal wastes and algae.

A80-52868 # Wind commercialization and Alcoa Vertical Axis Wind Turbines. P. N. Vosburgh (Aluminum Company of America, Alcoa Center, Pa.). In: Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings. Washington, D.C., Solar Energy Industries Association, 1979, p. 80-95.

Five basic Darrieus type Vertical Axis Wind Turbines which feature a troposkein shaped rotor blade are described along with the operation of several research machines including one of 17 m (60 kW) height and 61 cm chord blades that has demonstrated a performance coefficient of 42%. Some of the advantages of the design are the utilization of winds from all directions, a self-regulating system at constant rpm and its application in a cost effective, low maintenance, reliable energy source system. The commercialization efforts and various activities in support of wind energy conversion systems are discussed.

A.C.W.

A80-52881 # Investigation of the feasibility of methanol as an automobile fuel (Issledovanie vozmozhnosti primeneniia metanola kak topliva dlia avtomobil'nykh dvigatelei). M. Zugravel, R. Gaiginschi, V. Giurca, C.-A. Homutescu, N. Waszkiewicz, and D. Pasa (Iasi, Institutul Politehnic, Iasi, Rumania). Iasi, Institutul Politehnic, Buletinul, Sectia IV - Mecanica Tehnica, vol. 25, no. 3-4, 1979, p. 75-80. 9 refs. In Russian.

Experiments were conducted on the use of methanol as an automobile fuel; emphasis was placed on the selection of fuel system, i.e., carburetion or injection. Results indicate that methanol is a feasible automobile fuel.

B.J.

A80-52969 Relative merits of alternate linking techniques for underground coal gasification and their system design implications. D. W. Gregg (California, University, Livermore, Calif.). *In Situ*, vol. 4, no. 3, 1980, p. 207-236. 12 refs. Contract No. W-7405-eng-48.

A technico-economic analysis is made of the comparative merits of three linking techniques for underground coal gasification countercurrent combustion, directional drilling, and electrolinking. None of these techniques emerges as being superior for all applications, but rather each has its own specific set of physical parameters (coal conditions) that make it superior to the others under certain conditions. Plots illustrate a comparison of the costs of a directionally drilled link and a countercurrent-combustion link, revealing that direct drilling is always more expensive, though estimates indicate that it should be possible to reduce its cost to \$60 per foot of drilled hole, and that much longer spacings between access pipes may be employed after the link is drilled. The system design implications are discussed, and a novel approach to underground gasification of deep thin coal seams and at abandoned strip mines is presented.

A80-53057 Flue gas recirculation as a means of improving the solid waste incineration process. A. I. Urban and K. J. Thome-Kozmiensky (Berlin, Technische Universität, Berlin, West Germany). Resource Recovery and Conservation, vol. 5, Sept. 1980, p. 229-237. 34 refs.

The following objectives are particularly important as regards the improvement and further development of waste incineration facilities: raising the level of energy efficiency; reducing harmful emissions; and increasing plant reliability essentially through the reduction of corrosion problems. It should be examined whether flue gas recirculation represents a suitable means for optimizing waste incineration. This involves ascertaining how flue gas recirculation, i.e., the return of a part of the flow of flue gases from the boiler outlet back into the combustion chamber, affects the energy balance of the entire process, the formation of harmful material, and the degree of damage caused by corrosion and erosion. (Author)

A80-53174 The hydropyrolysis of coal to BTX. G. Fynes, W. R. Ladner, and J. O. H. Newman (Coal Research Establishment, Cheltenham, Glos., England). *Progress in Energy and Combustion Science*, vol. 6, no. 3, 1980, p. 223-232. 70 refs. Research supported by the European Coal and Steel Community.

The importance of hydropyrolysis as a coal-to-liquid route is considered. Yields of benzene, toluene, and xylenes of up to 15% w/w were obtained from bituminous coal and lignite by using very rapid heating (about 1000 K/sec) to 1000-1100 K in hydrogen pressures in the range 100-200 bar at optimum vapor residence times. The yields obtained by various workers and the mechanisms of the formation of BTX from coal by hydropyrolysis are discussed.

(Author)

A80-53274 Research needs for coal gasification and coal liquefaction. S. S. Penner, S. B. Alpert, V. Bendanillo, J. Clardy, L. E. Furlong, F. Leder, L. Lees, E. Reichl, J. Ross, and R. P. Sieg (California, University, La Jolla, Calif.). *Energy* (UK), vol. 5, Nov. 1980, p. 1091-1116. 6 refs.

Development of coal-gasification and coal-liquefaction technologies is discussed. Consideration is given to applications of coal-gasification technologies, the principal coal-gasification systems, and process-research recommendations. Processing steps in direct and indirect coal liquefaction are outlined, with emphasis placed on past, current, and projected unit sizes of direct coal-liquefaction plants.

V.T.

A80-53323 The extraterrestrial imperative. III - New earth-space energy metabolism. I. K. A. Ehricke (Space Global Co., La Jolla, Calif.). British Interplanetary Society, Journal (Interstellar Studies), vol. 33, Nov. 1980, p. 379-390. 8 refs.

The use of space technology to support near-term options producing energy to meet increasing demands is discussed. The outlook for future energy demands for industrial, agricultural and standard of living applications is considered for the long and short terms, together with the available terrestrial resources, including fossil fuels, nonfossil chemical fuels and nuclear fission energy for the near term. The potential provided by the use of space technology to support the fossil fuel option by the location of oil and coal reserves and to support the nuclear option by the disposal of long-lived radioactive wastes is examined. It is shown that the use of the Space Shuttle to transport the highly radioactive fission products Sr, Y, Cs, Sb, Np, Am, and Cm into heliocentric orbit away from the earth's vicinity would be energetically and economically feasible at least until the 1990s and would accelerate the advancement of space industrialization.

A.L.W.

A80-53474 The potential role of biofuels within the built environment. C. Lewis. *International Journal of Ambient Energy*, vol. 1, Apr. 1980, p. 99-109. 40 refs.

The potential contribution of biofuels within both developed and developing nations is examined, particularly with respect to their utilization within the built environment. It is stressed that biomass, mainly in the forms of wood, animal dung and agricultural residues, is essentially a renewable resource and today accounts for approximately one-sixth of global fuel supplies. Examples of fuelwood consumption in European countries and in Africa are presented and the future of the bioenergy is considered, taking into account such main estimates as national energy density (energy consumed/ha of land area) and biomass productivity (net energy output/ha/year). Bioenergy production in low and high latitude countries, is also examined. The results of work on the blue-green Spirulina, an alga which contains 65-70% protein, and may yield about 200 cu m of biogas, containing 65-68% of CH4 at an energy content of 5.25 GI from 410 kg of its biomass are discussed.

A80-53680 Tidal energy in the Bay of Fundy. R. G. Tanner and D. F. Murphy (Canadian Atlantic Power Group, Ltd., Toronto, Canada). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 91-99. 7 refs.

The tides in the Bay of Fundy on the eastern seaboard of Canada are among the highest in the world. In studies carried out between 1975 and 1977, sites were selected for tidal power developments and estimates made of at-site costs of electrical energy. The studies included preliminary optimization of turbine generator equipment and development designs and layouts. The results of the studies showed that construction of tidal power plants is feasible, new developments in equipment and construction techniques will likely help reduce the cost of tidal energy, and tidal energy can be accepted into projected power systems at an attractive enough cost relative to that projected for fossil fueled generation to justify development of tidal power. (Author)

A80-53681 Ocean wave power available to submerged energy devices of finite dimensions. J. M. Niedzwecki (Texas A & M University, College Station, Tex.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 100-106. 14 refs.

The feasibility of deploying wave energy converters at offshore sites near coastal population centers depends upon many factors. Some of the factors to be considered include preliminary power estimates for site selection, converter design, mooring or restraining problems and power transmission to shore. The accuracy of the preliminary wave power estimates depends upon the accuracy and extent of the site wave climate data and some geometrical aspects of the proposed converter. Specifically, information describing the converter's length, vertical height, degree of submergence and orientation with respect to incident waves must be considered. This investigation examines the influence of these geometrical aspects upon single wave and spectral wave power estimates. (Author)

A80-53682 Tidal energy and the energy crisis - An assessment of technology and the interrelationship. M. S. Berryman (District of Columbia, University, Washington, D.C.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 107-116. 38 refs.

Past and present technological innovations and research related to the energy crisis are assessed. Particular attention is given to the development of tidal power plants, with emphasis on the past and present status of the Passamaquoddy-Cobscook Bay Dam Project. The benefits and environmental effects associated with tidal power development are examined.

A80-54034 Methane formation during hydrogen gasification and gas phase pyrolysis of selected aromatics (Methanbildung bei Wasserstoffvergasung und Gasphasenpyrolyse definierter Aromaten). W.-D. Gräber and K. J. Hüttinger (Karlsruhe, Universität, Karlsruhe, West Germany). Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie, vol. 33, Sept. 1980, p. 416-420. 23 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

The paper discusses the influence of functional groups containing oxygen on the methane formation during the gasification of structural elements of coal. Benzoic acid, p-benzoquinone, phenol, 1-naphthol and diphenyleneoxide were tested. The splitting of the carbonyl group has no effect on the pyrolysis and methane formation. The carbonyl group is more stable than the carboxyl group, their splitting as CO can, however, favor the methane formation. The hydroxyl group can react in different ways. The high temperature splitting of oxygen to form CO while opening the aromatic ring is of special interest, since this highly accelerates the methane formation. The oxygen of the ether bridge in diphenyleneoxide is also liberated as CO, which also favors the methane formation. As possible condensation product of phenol diphenyleneoxide or its oxygen is less active than phenol with respect to CO splitting. (Author)

A80-54036 The renaissance of coal (Die Renaissance der Kohle). E, Meller (International Energy Agency, Paris, France). Erdöl und Kohle Erdgas Petrochemie vereinigt mit Brennstoff-Chemie, vol. 33, Sept. 1980, p. 441-444. In German.

The increased use of coal as an energy source is explored. Coal reserves are vast and widely distributed, in contrast to oil, and import coal was competitive with oil on the world market prior to the recent rise in oil prices. Coal output in 1977 and projections for the year 2000 are discussed in relation to oil and atomic energy production. Figures on coal consumption for countries in the Organization for Economic Cooperation and Development are presented for 1977,

1985 and 2000. A rise in coal production would pose demands on production and could cause environmental problems. Sulfur removing plants would be necessary to treat the coal with high sulfur content and the increased emission of CO2 may promote a greenhouse effect.

A80-54063 A problem posed by vapour-dominated geothermal systems. G. Schubert (Aerospace Corp., Space Sciences Laboratory; California, University, Los Angeles, Calif.), J. M. Straus (Aerospace Corp., Space Sciences Laboratory, Los Angeles, Calif.), and M. A. Grant (Department of Scientific and Industrial Research, Applied Mathematics Div., Wellington, New Zealand). Nature, vol. 287, Oct. 2, 1980, p. 423-425. 8 refs. NSF Grant No. ENG-76-82119.

Vapor-dominated geothermal systems present an apparently extraordinary physical phenomenon - a layer of water lying stably on a body of steam. The first geothermal exploitation at Lardarello, Italy, was in such an area. An analysis of the gravitational stability of water over steam in a porous medium is presented here. This shows that the near-surface condensate layer of a vapor-dominated geothermal system can be stably maintained above the main steam reservoir by restoring forces associated with the displacement of the phase-change interface. For typical conditions in vapor-dominated geothermal systems, stability can be maintained provided that the permeability of the rocks at the depth of the steam-water boundary does not exceed about 40 sq nm (0.04 millidarcy). The stability requirement determines the thickness of the condensate layer or the proximity of the top of the steam reservoir to the surface. (Author)

A80-54077 The potential and economics of wind energy An investigation commissioned by the International Energy Agency for the Federal Republic of Germany (Windenergie - Potential und Wirtschaftlichkeit - Untersuchung im Auftrag der Internationalen Energieagentur für die Bundesrepublik Deutschland). L. Jarass and G. Obermair. Energiewirtschaftliche Tagesfragen, vol. 30, Sept. 1980, p. 672-675. 14 refs. In German.

The final report of the research commissioned by the International Energy Agency at the University of Regensburg on the integration of wind power plants and public electrical energy supplies is discussed. The economic optimization of the fluctuating wind energy supplies, and the changing electrical demand is investigated along with the regulation of present power plants and storage systems. Wind power plants with 6 GW(e) installed capacity cover approximately 7 per cent of the electricity demand with an energy production of 19 TWh(e), and replace with 1500 MW approximately 2.2 per cent of the conventional power plant performance. Fossil fuel saving is also considered in relation to wind power performance.

N80-28478# Missouri Univ. -Rolla. Materials Research

CHEMICAL AND PHYSICAL STABILITY OF REFRACTORIES FOR USE IN COAL GASIFICATION Quarterly Progress Report. 1 Nov. 1979 - 31 Jan. 1980

Abbas Fakhr and Delbert E. Day 31 Jan. 1980 29 p (Contract EY-76-S-02-2904)

(COO-2904-15; QPR-15) Avail: NTIS HC A03/MF A01

The dependence of the chemical reactions occurring in the cement bond portion of the castables upon the degree of saturation was determined for pure steam and the DOE atmosphere. Boehmite, C4A3H3 and calcite are the major components formed. Only the amount of boehmite varied significantly with the degree of saturation. A linear relationship exists between the percent saturation and the amount of boehmite up to 70%, saturation. Above 70%, the amount of boehmite is nearly constant and independent of the degree of saturation. The minimum percent saturation required to form boehmite varied from 10% to 30% according to the atmosphere and pressure. Mechanical properties (namely flexural strength) also varied with the percent saturation. Those parts of the specimens exposed to greater than 50% saturated atmosphere were appreciably stronger (2 to 3 times). The relative severity of the corrosion of several refractory castables by either liquid or saturated vapor was determined for pure steam.

the DOE atmosphere, and CO-steam atmospheres. The thermal expansion data obtained for the castables after exposure to above mentioned atmospheres and conditions are summarized.

N80-28482# Delaware Univ., Newark. Dept. of Chemical Engineering.

DEVELOPMENT OF UNIQUE CATALYSTS FOR HYDRODE-NITROGENATION OF COAL-DERIVED LIQUIDS Quarterly Report, 15 Sep. - 15 Dec. 1978

James R. Katzer, Alvin B. Stiles, and Harold Kwart 1 Mar. 1979 122 p refs

(Contract EI-78-S-01-3297)

(FE-3297-1; QR-1) Avail: NTIS HC A06/MF A01

Four experimental runs were made: two used decahydroquinoline as reactant and two runs were made using orthoethylaniline and quinoline-N-oxide respectively. The decahydroquinoline runs indicate that the carbon-nitrogen bond scission is not thermal but clearly catalytic. Important findings resulted from the run using oethylaniline and future runs will help define reaction pathways. Quinoline-N-oxide was rapidly deoxygenated to form quinoline under the conditions tested. Future runs will be conducted in the absence of hydrogen to avoid deoxidation of quinoline-N-oxide and to find out whether carbon-nitrogen bond scission can be promoted by the addition of oxygen to the quinoline molecule. A review paper has been prepared that reviews the existing chemistry and technology for hydrodenitrogenation of synthetic feedstocks and heavy petroleum liquids. It projects what should be a more effective means and more rational basis for the design and development of more active and more selective catalysts for hydrodenitrogenation and attempts some speculations on potentially fruitful direction to be followed in both catalyst and process development.

N80-28542# Badger Plants, Inc., Cambridge, Mass.
ASPECTS OF COMMERCIALIZING COAL-DERIVED ME-THANOL FUELS IN THE UNITED STATES, 1985 TO 2000. **VOLUME 1: MARKET EVALUATION** 

Mar. 1980 173 p refs

(Contract EX-76-C-01-2416)

(FE-2416-44-Vol-1) Avail: NTIS HC A08/MF A01

The prospects of coal derived fuels are evaluated only for those segments of the electric utility and automotive sectors considered most likely to provide markets for such fuels in the near term. The commitment of the electric utility industry to the use of methanol as a peakload turbine fuel is predicted upon both future and price supply. Results indicate that methanol appears to be an acceptable replacement gas turbine fuel and that the technical problems should be solvable. DOE

N80-28543# Badger Plants, Inc., Cambridge, Mass. ASPECTS OF COMMERCIALIZING COAL-DERIVED METHA-NOL FUELS IN THE UNITED STATES, 1985 TO 2000. VOLUME 2: APPENDIX Mar. 1980 231 p refs

(Contract EX-76-C-01-2416)

(FE-2416-44-Vol-2) Avail: NTIS HC A02/MF A01

Various aspects of the commercializing of methanol fuel and synthetic gasoline in the United States during the period 1985 to 2000 are evaluated. Major emphasis is placed on electric utility industry and the automotive sector. Competing alternative fuels RCT are also reported.

N80-28545# Delaware Univ., Newark. Dept. of Chemical

DEVELOPMENT OF UNIQUE CATALYSTS FOR HYDRODE-NITROGENATION OF COAL-DERIVED LIQUIDS Quarterly Report, 15 Dec. 1978 - 15 Mar. 1979

James R. Katzer, Alvin B. Stiles, and Harold Kwart 15 May 1979 31 p

(Contract ET-78-S-01-3297)

(FE-3297-2: QR-2) Avail: NTIS HC A03/MF A01

Experimental runs using decahydroquinoline, o-ethylaniline, and aniline as reactants were made. Results from decahydroguinoline runs show that carbon-nitrogen bond scission occurs by a catalytic route; it is not thermal. Strong Bronsted acid sites do

not crack carbon-nitrogen bond; carbon-nitrogen bond scission must therefore occur on other sites on the catalyst. Hydrodenitrogenation of anilines clearly shows kinetic behavior characteristic of hydrogenation including positive order dependence on hydrogen pressure and an activation energy between that for hydrogenation and that for cracking; yet the primary product appears to be the fully aromatic ring. Hydrodenitrogenation of aniline and o-ethylaniline was studied over a presulfided Ni-Mo/ AI2O3 catalyst, and a reaction network was determined for aniline hydrodenitrogenation. Aniline hydrodenitrogenation appears to involve partial hydrogenation of the benzene ring to reduce aromatic resonance with the nitrogen atom reducing the C-N bond strength and facilitating elimination of NH3. DOE

N80-28546# Delaware Univ., Newark. Dept. of Chemical Engineering.

DEVELOPMENT OF UNIQUE CATALYSTS FOR HYDRODE-NITROGENATION OF COAL-DERIVED LIQUIDS. Quarterly Report, 15 Mar. - 15 Jun. 1979

James R. Katzer, Alvin B. Stiles, and Harold Kwart. 1 Aug. 1979 57 p

(Contract ET-78-S-01-3297)

(FE-3297-3: QR-3) Avail: NTIS HC A04/MF A01

Experimental runs using decahydroquinoline and quinoline as reactants were made. The nature of catalytic function responsible for carbon-nitrogen bond session was studied using decahydroquinoline over a set of catalysts. The catalysts tested include catalysts with Co, Ni, Mo impregnated on silica-alumina or gamma-alumina. The results showed that the rate of nitrogen removal and highest for Mo on gamma-alumina catalyst. Several catalysts with the objective to develop uniquely new hydrogenation catalysts that will selectively coordinate the nitrogen atom and remove it without hydrogenating the entire ring thereby reducing hydrogen consumption, were prepared. The catalysts chosen were aluminum borate and aluminum borate phosphate, impregnated with 4 wt % nickel. Preliminary results showed that 4 wt % Ni on aluminum borate catalyst gives a marked increase in nitrogen removal in quinoline. DOE

N80-28547# Los Alamos Scientific Lab., N. Mex.
ALTERNATIVE GAS WORKSHOP Final Report
Glenda Cremer, comp., Mar. 1980 58 p. refs. Workshop held

at Los Alamos, N. Mex., 5-6 Sep. 1979 (Contract W-7405-eng-36)

(LA-8155-C; CONF-7909133) Avail: NTIS HC A04/MF A01 Basic research needs in the development of seven categories of unconventional and nonconventional gas resources were reviewed. The categories reviewed were Devonian shales, western tight gas sands, methane from coal beds, geopressured brines, methane hydrates, abiogenic methane, and other geological environments. The principal recommendations of the workshop groups are presented.

N80-28548# Air Products and Chemicals, Inc., Allentown, Pa. CRYOGENIC METHANE SEPARATION/CATALYTIC HY-DROGASIFICATION PROCESS ANALYSIS Interim Report A. A. Cassano, M. F. Hilton, and T. C. Li 15 May 1979 96 p.

(Contract ET-78-C-01-3044)

(FE-3044-T6) Avail: NTIS HC A05/MF A01

Attractive combinations of acid gas removal and cryogenic methane separattion for both the catalytic coal gasification and the hydrogasification processes are suggested. A screening process was undertaken to define the most promising integration scheme for each gasification process. This information, combined with present capabilities in acid gas processes and cryogenic separation, allowed preparation of process designs and cost, estimates for each of the integrated schemes.

N80-28549# Ames Lab., Iowa. MATERIALS FOR COAL LIQUEFACTION

Tom E. Scott Oct. 1979 - 71 p refs. Presented at the 4th Ann. Conf. on Mater. for Coal Conversion and Utilization, Gaithersburg, Md., 9-11 Oct. 1979; sponsored by DOE, Electric Power Research Inst., NBS and Gas Research Inst.

(Contract W-7405-eng-82)

(ISM-246; CONF-791014-1) Avail: NTIS HC A04/MF A01 An attempt is made to summarize the failures already experienced, most of which are highly visible such as erosion or corrosion. Problems which are not failures but bear on cost effectiveness as well as potential problems which might effect reliability and safety are indicated. The efforts being made to solve these problems are cited and some future directions for consideration are suggested. It is shown that solutions to problems uncovered in pilot plant scale operations may not suffice in commercial scale plants. On the other hand, some pilot plant problems may be eliminated or mitigated in large components for commercial plants.

N80-28550# Chevron Research Co., Richmond, Calif. REFINING AND UPGRADING OF SYNFUELS FROM COAL AND OIL SHALES BY ADVANCED CATALYTIC PROCESSES

Quarterly Report, Apr. - Jun. 1979 R. F. Sullivan and D. J. Rear Jul. 1979 79 p

(Contract EX-76-C-01-2315)

(FE-2315-40) Avail: NTIS HC A05/MF A01

Pilot plant results for a two stage hydrocracker are presented. It is shown that H-coal whole process product can be hydrotreated to make a jet fuel similar to the jet fuel from SRC-2 whole process product.

N80-28651# Engineering Societies Commission on Energy, Inc., Washington, D. C.

SURVEY OF WORLD COAL ENERGY STUDIES AND INTERNATIONAL COAL MINING RESEARCH

T. A. Boyce Dec. 1979 80 p (Contract EF-77-C-01-2468-012)

(FE-2468-68) Avail: NTIS HC A05/MF A01

An international monitoring task was undertaken with emphasis on monitoring the awareness of international energy programs. The findings of the monitoring activities are summarized with respect to the following: world coal energy studies: international coal mining research; and world coal trade.

N80-28552# Germantown Labs., Inc., Philadelphia, Pa. INVESTIGATION OF FUELS CONTAINING COAL-OIL-WATER EMULSIONS FIRE TUBE TEST APPARATUS Quarterly Report, 1 Jan. - 31 Mar. 1980.

Norman H. Cherry and Charles S. Stokes Jan. 1980 12 p

(Contract DE-AC22-77ET-10634)

(DOE/ET-10634/T1; QR-10) Avail: NTIS HC A02/MF A01 The fire tube test apparatus was checked out and is ready for the combustion test series. The stack gas analysis equipment was calibrated and operational procedures evaluated for data acquisition. In conjunction with the fire tube test apparatus, a commercial scale size Gaulin emulsifier (100 gallons/hour) was set up and evaluated.

N80-28553# Filtrol Corp., Los Angeles, Calif.
DEVELOPMENT OF NEW CATALYSTS FOR COAL LIQUIDS REFINING Quarterly Report, 1 Jul. - 30 Sep. 1979

I. Schwager Oct. 1979 27 p refs (Contract ET-78-C-01-2595)

(FE-2595; QR-3) Avail: NTIS HC A03/MF A01

Base line catalyst testing conditions for hydrotreating SRC-2 fuel oil blend were determined: temperature, 750 F; pressure, 1,000 psig; LHSV, 1 ml/ml-hr; and H2 flow rate, 5000 SCF/bbl. At these conditions the average values for HDN and HDS with the commercial Filtrol catalyst HPC-40 (Ni-Mo on gamma alumina) are 88 + or - 2 and 89 + or - 2%, respectively. With Filtrol HP-6 (Co-Mo on gamma alumina) the HDN and HDS values are 78 and 92%, respectively. Hydrotreating catalyst testing on a series of exploratory catalysts, with different metals loadings and support properties, was initiated. Nickelmolybdenum catalysts appear to be more active for HDN, whereas, Co-Mo catalysts appear to be more active for HDS. Both Ni-W and Co-W catalysts appear to be less active than their Ni- and Co-Mo counterparts. Pilot Plant batches of silica alumina, silica alumina magnesia, and silica alumina zirconia gels were prepared. Exploratory cracking, hydrocracking, and hydrotreating catalysts are being produced in preparation for activity testing.

N80-28554# Lummus Co., Bloomfield, N. J. DEVELOPMENT RESEARCH PROGRAM FOR CLEAN INDUSTRIAL AND TRANSPORTATION FUELS FROM COAL Final Report, Sep. 1976 - Mar. 1979

H. D. Schindler and R. H. Long Dec. 1979 171 p refs (Contract EF-76-C-01-2514)

(FE-2514-31) Avail: NTIS HC A08/MF A01

The potential performance of single axis tracking parabolic trough solar collectors as a function of optical energy distribution and receiver size was calculated for eleven sites using typical meteorological year input data. A simulation based on the SOLTES code was developed which includes the three dimensional features of a parabolic trough and calculates the thermooptical tradeoffs. The capability of the thermooptical model was confirmed by the comparison of calculated results with the experimental results from an all day test of a parabolic trough. The results indicate a potential performance superiority of a north-south horizontal axis trough and, in addition, a high quality (optical error sigma sub system less than or equal to 0.007 radian) collector should be of the same geometric design for all of the sites investigated and probably for all regions of the country.

N80-28555# Worcester Polytechnic Inst., Mass. KINETICS AND MECHANISMS OF CATALYTIC HYDROLI-QUEFACTION AND HYDROGASIFICATION OF LIGNITE Quarterly Report, Jul. - Sep. 1979 Alvin H. Weiss and Wilmer L. Kranich 25 Oct. 1979 8 p

(Contract EF-77-S-01-2702)

(FE-2702-8) Avail: NTIS HC A02/MF A01

Several successful runs on hydrogenation of a 20% slurry of lignite in anthracene oil were made at 425 C in a CSTR. At constant concentration of unconverted coal solids, the rate of reaction appears from very limited data to be independent of hydrogen pressure over a total pressure range of 800 to 1600 psig. Rate also appears to be independent of concentration of Co-Mo catalyst over the range of 0.8% to 2.0% of total charge. If these results can be reproduced and extended, this may indicate that over these ranges, hydrogen is supplied and activated by the catalyst at a rate well in excess of that at which it can be utilized by the slower hydroliquefaction reac-

N80-28556# Oklahoma State Univ., Stillwater. School of Chemical Engineering. CATALYSTS FOR UPGRADING COAL-DERIVED LIQUIDS

Quarterly Report, 1 Jan. - 31 Mar. 1980 Billy L. Crynes 15 Apr. 1980 18 p (Contract DE-ACO1-79ET-14876)

(DOE/ET-14876/2) Avail: NTIS HC A02/MF A01

Construction of the new trickle-bed reactor was completed and one experiment was conducted. The experimental run was made using a Pamco coal-derived liquid containing 0.40% sulfur and 0.95% nitrogen. The catalyst utilized was HDN-30, Ni-Mo-Al2O3. Run conditions were at 399 C (750 F), 1500 psig and space times up to two hours. Sample analyses are not yet available from this experiment. Two runs were completed in the Catalyst Life Test Unit (CLTU) utilizing a liquid containing 50% Synthoil and 50% Raw Anthracene oil. This fluid has a 0.54% sulfur and 1.21% nitrogen. Two Ni-MoAl2O3 catalysts were used - Shell-324, and H-Oil. Both experiments were terminated prematurely because of equipment malfunction. Sample analyses are not yet available from these two experiments.

N80-28558# Utah Univ., Salt Lake City. Dept. of Mining, Metallurgical and Fuels Engineering.

APPLIED RESEARCH AND EVALUATION OF PROCESS CONCEPTS FOR LIQUEFACTION AND GASIFICATION OF WESTERN COALS Quarterly Progress Report, Apr. - Jun.

Wendell H. Wiser Oct. 1979 88 p refs (Contract EX-76-C-01-2006) (FE-2006-16) Avail: NTIS HC A05/MF A01

Problems in four general areas are considered: evaluation of process concepts in relation to liquefaction and gasification

of coal; catalysis studies of fundamental importance in liquefaction and gasification of coal; studies of fundamental principles involved in processes for liquefaction and gasification of coal: and properties of coal and coal conversion products, of significance in liquefaction and gasification of coal. Research highlights are: (1) A reaction pathway for hydrodeoxygenation of oxygen containing species is proposed based on studies of model compounds. Reaction pathways that can lead to coke formation and catalyst deactivation and identified; (2) Studies on the hydrodesulfurization of thiophene support the Kolbe mechanisms; and (3) Preasphaltenes produced at low conversions were characterized. The heteroatom content is similar to that of the original coal and less than that of asphaltenes and oils. The carbon aromaticity is 0.6 to 0.7, but the molecules contain only 1-2 aromatic rings per condensed ring system.

N80-28560# Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

ALTERNATIVE PROCESS SCHEMES FOR COAL CONVER-SION Progress Report, 1 Jun. - 31 Aug. 1979

Michael J. Sansone and Vi-Duong Dang Oct. 1979

(Contract EY-76-C-02-0016)

(BNL-51117; PR-3) Avail: NTIS HC A02/MF A01

To obtain pipeline grade methane, it is necessary to develop economical methods of separating methane from hydrogen and/or carbon monoxide mixtures. The hydrogen and carbon monoxide are then recycled in the process. Several separation technologies such as absorption/stripping, cryogenic, clathrate formation were examined. An absorption/stripping process calculation using propane as the absorption solvent for separation of methane from hydrogen and carbon monoxide was performed. Detailed material and energy balances for the process as well as the dimensions of the absorber and the stripper are reported. Other major pieces of equipment such as heat exchangers, pumps. and compressors were evaluated in order to determine the equivalent electrical energy of the process as approximately 13550 cal(e)/gm-mole methane produced. The purity of methane in the final stream is 96% by volume at 100 F and 1000 psi. The present process appears to be a potential working process for methane separation in large quantity.

N80-28561# SRI International Corp., Menlo Park, Calif. Materials Research Lab.

SHIFT CONVERSION AND METHANATION IN COAL GASIFICATION: BENCH-SCALE EVALUATION OF A SULFUR RESISTANT CATALYST Quarterly Progress Report, 1 Oct. - 31 Dec. 1979

B. J. Wood, D. Sheridan, J. G. McCarty, and H. Wise 18 Jan. 1980 16 p refs

(Contract ET-78-C-01-3240; SRI Proj. PYU-7930) (FE-3240-T4) Avail: NTIS HC A02/MF A01

A bench-scale, long term study is in progress of the deactivation rate of a new methanation catalyst which in earlier laboratory measurements demonstrated both higher specific methanation activity and resistance to sulfur poisoning. The measurements are carried out in two parallel, fixed-bed reactors one of which contains Ir/Ni/Al2O3 and the other Ni/Al2O3. The deactivation rates were examined in terms of the loss in conversion with exposure time to the syn gas mixture, the change in temperature distribution along the axis of the catalyst bed, and the breakthrough of hydrogen sulfide in the product stream. For the same mass of catalyst and Al2O3 diluent the Ir/Ni/Al2O3 samples exhibited a considerably longer life than Ni/Al2O3. After 800 hours of operation the Ni/Al2O3 has lost nearly 99 percent of its initial activity, while the activity loss amounts to only 25 percent in the case of Ir/Ni/Al2O3. DOF

N80-28562# Sandia Labs., Albuquerque, N. Mex. Processes Div.

INSTRUMENTATION AND PROCESS CONTROL DEVELOP-MENT FOR IN SITU COAL GASIFICATION Quarterly Report, Sep. - Nov. 1979

Robert E. Glass, ed. Apr. 1980 25 p refs (Contract EY-76-C-04-0789)

(SAND-80-0482; QR-20) Avail: NTIS HC A02/MF A01

The second phase of the Hanna 4 in situ coal gasification test, Hanna 4-B, which was initiated on April 20, 1979, was completed on October 4, 1979. Sandia National Laboratories provided support by fielding and monitoring diagnostic and remote monitoring instrumentation techniques. During the final gasification stage, 765 tons of coal were reacted involving 17,000 cubic feet. The Hoe Creek 3 experiment began on August 15, 1979. and was terminated on October 10, 1979. The purpose of the experiment was to test the drilled borehole linking concept. Sandia National Laboratories' involvement consisted of fielding and monitoring both an inverted thermocouple and a surface electrical resistivity network. The inverted thermocouple was successfully tested and provided thermal data from beneath the burn zone. A real time analysis procedure for the electrical resistivity technique was implemented at Hoe Creek 3. Unfortunately, there was insufficient change in the data for this to have been a useful diagnostic. Efforts are continuing to identify the reason for this lack of response.

N80-28563# Energy Resources Co., Inc., Cambridge, Mass. FEASIBILITY OF ALTERNATIVES FOR SURFACE UTILIZA-TION OF COAL WASTES Final Technical Report, 29 Jul. 1979

J. Gushue Jul. 1979 287 p refs (Contract ET-78-C-01-3105)

(FE-3105-1) Avail: NTIS HC A13/MF A01

The feasibility of using coarse coal refuse in combination with power plant fly ash to form subbase coarse material for roadway construction is evaluated for the Monogalia County region in northern West Virginia. On the basis of technical, environmental. and economic factors, it is concluded that using coal refuse/fly ash material for roadway subbase construction is feasible in the study area. The key technical and environmental considerations are related to the compaction characteristics of the material. Chemical and physical testing of the material to establish properties, in place performance, and optimum refuse/fly ash blends followed by proper mixing, handling and compaction during construction results in a strong, environmentally benign subbase course. Maximum usage of coal refuse/fly ash (3/1 ratio) on the 127 miles of new roadway planned through 1985 would utilize about 2.3 million tons of an estimated 7.5 million tons of refuse to be generated in the study area.

N80-28566# Chem Systems Research Center, Fairfield, N.J. DEVELOPMENT OF ALCOHOL-BASED SYNTHETIC TRANS-PORTATION FUELS FROM COAL-DERIVED SYNTHESIS GASES Quarterly Report, 14 Sep. - 14 Dec. 1979

8 Apr. 1980 68 p refs (Contract DE-AC22-79ET-14858)

(DOE/ET-14858/T1; QR-1) Avail: NTIS HC A04/MF A01 Chem Systems is carrying out an experimental program for the conversion of coal-derived synthesis gases to a mixture of C1-C4 alcohols. The objectives are to develop a catalyst and reactor system for producing a mixture of C1-C4 alcohols, which we call Alkanol fuel, to be used as a synthetic transportation fuel and assess the technical and economic feasibility of scaling the process concept to a commercial-scale application. Some of the accomplishments made were: (1) a small (75cc) fixed-bed, plug-flow, vapor phase reaction system was set up and operated utilizing catalyst bed dilution with inert media to help limit the large exotherm associated with the synthesis gas conversion reactions; (2) a total of fifteen catalysts containing varying amounts of Cu, Co, Zn, Cr and K were prepared and seven of these catalysts were tested: (3) identification of one promising catalyst composition which has resulted in a 30% conversion of carbon monoxide per pass (synthesis gas had a 3.5 H2/CO ratio) with a carbon selectivity to alcohols of about 80%.

N80-28567# Chem Systems Research Center, Fairfield, N.J. LIQUID-PHASE METHANOL Final Report, Dec. 1979 M. Sherwin and D. Blum Dec. 1979 245 p Sponsored by Electric Power Research Inst. (EPRI Proj. 317-2)

(EPRI-AF-1291) Avail: NTIS HC A11/MF A01

The concept of this reactor involves carrying out the synthesis of methanol in an ebullated bed of catalyst in the presence of an inert liquid heat carrier. Work was carried out on laboratory, continuous bench-scale, and a process development unit. DOE

N80-28570# Energy and Environmental Analysis, Inc., Arlington, Va

TECHNICAL AND ECONOMIC FEASIBILITY OF ALTERNATIVE FUEL USE IN PROCESS HEATERS AND SMALL BOILERS

Feb. 1980 300 p

(Contract DE-AC01-79EI-10547)

(DOE/EIA-10547/01) Avail: NTIS HC A14/MF A01

The technical and economic feasibility of using fuels other than oil and natural gas in combustors not regulated by the Powerplant and Industrial Fuel Use Act of 1978 (FUA) was evaluated. The impact of several measures to encourage the substitution of alternative fuels in these combustors was analyzed. The primary processes in which significant fuel savings can be achieved were identified. The combustors evaluated comprise approximately 45% of the fuel demand projected in 1990. These uses would account for more than 3.5 million barrels per day equivalent fuel demand in 1990.

N80-28571# Department of Energy, Washington, D. C. Office of Transportation Programs.

ALTERNATIVE FUELS, FUEL ADDITIVES AND RELATED DEVICES FOR HIGHWAY VEHICLES: R, D AND D PROPOSAL GUIDELINES

Apr. 1980 25 p

(DOE/CS-0154) Avail: NTIS HC A02/MF A01

A technology is described which will help decrease U.S. dependence on and eventually replace petroleum as a major fuel resource. Alternative fuels, fuel additives, and engine/vehicle hardware that relate specifically to alternative fuels) handling and management are emphasized. Test data requirements for alternative fuels, fuel additives, extenders, and alternative fuel and related devices and systems are presented. A summary of submission requirements is also included.

N80-28572# New Zealand Energy Research and Development Committee, Auckland.

THE POTENTIAL OF ENERGY FARMING FOR TRANSPORT FUELS IN NEW ZEALAND

G. S. Harris, M. L. Leamy, T. Fraser, J. B. Dent, W. A. N. Brown, W. B. Earl, and T. W. Fookes Aug. 1979 130 p refs Prepared in cooperation with Dept. of Scientific and Industrial Research, New Zealand and Soil Bureau, Forest Research Inst., Lincoln Coll., Canterbury Univ., and Waikato Univ. (PB80-154248: Rept-46) Avail: NTIS HC A07/MF A01 CSCL

(PB80-154248; Rept-46) Avail: NTIS HC A07/MF A01 CSCL 21D

The main economic aspects or energy farming are discussed. A set of guidelines are considered along which it is believed energy farming should or could be developed. Environmental and social factors associated with energy farming implementation are also considered.

GRA

N80-28573# New Zealand Energy Research and Development Committee, Auckland.

THE POTENTIAL OF ENERGY FARMING FOR TRANSPORT FUELS IN NEW ZEALAND, APPENDICES

G. S. Harris, M. L. Leamy, T. Fraser, J. B. Dent, W. A. N. Brown; W. B. Earl, T. W. Fookes, and J. Gilbert Aug. 1979 134 p refs Prepared in cooperation with Dept. of Scientific and Industrial Res., New Zealand, Soil Bureau, Forest Res. Inst., Lincoln Coll., Canterbury Univ., and Waikato Univ.

(PB80-154255; Rept-46-App) Avail: NTIS HC A07/MF A01 CSCL 21D

The inventory of land suitable for the growth of crops necessary for biomass energy production is considered. Suitability prescriptions for mapping the distribution of resources needed for this process are presented.

N80-28574# Office of Technology Assessment, Washington, D. C.

ALTERNATIVE ENERGY FUTURES. PART 1: THE FUTURE OF LIQUEFIED NATURAL GAS IMPORTS

Mar. 1980 133 p

(PB80-173552: OTA-E-110) Avail: NTIS HC A07/MF A01 CSCL 21D

Worldwide availability of natural gas for U.S. import as liquefied natural gas is discussed with respect to projected U.S. gas demand, alternative North American oil and gas resources, and the security of foreign supplies. Sections on LNG project structure, cost, and financing are included. Observations about balance of payment impacts and public exposure to financial risk are also reported.

.N80-28724# Encotech, Inc., Schenectady, N.Y.

WORLDWIDE SURVEY OF CURRENT EXPERIENCE BURNING RESIDUAL AND CRUDE OILS IN GAS TURBINES Final Report

B. O. Buckland, F. H. Kindl, and H. Lukas Dec. 1979 87 prefs

(EPRI-AF-1243) Avail: NTIS HC A05/MF A01

Owners of gas turbines burning residual fuel were surveyed to identify operating problems, costs, and general owners' reaction to burning residual fuel. Owners were contacted by mail and personal visits and the results are summarized. The general conclusion is that residual oil is a practical fuel for gas turbines. It is also indicated that capital and operating costs will be higher and extra attention to system design is required as compared with distillate operation. When the cost differential between distillate and residual (or crude) fuel justifies it, residual is a practical alternative.

N80-28726# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

DEVELOPMENT OF HIGH TEMPERATURE TURBINE SUBSYSTEM TECHNOLOGY TO A TECHNOLOGY READINESS STATUS, PHASE 2 Quarterly Report, Apr. - Jun. 1979

1979 207 p refs (Contract EX-76-C-01-1806)

(FE-1806-67); Avail: NTIS HC A10/MF A01

Progress in a program for developing a gas turbine for use in a combined-cycle power plant using coal-derived gas fuel combusted at temperature from 2600 F to 3000 F is reported. Information is included on component design and testing, system design and performance analyses, and updating the previous combined-cycle studies to evaluate the commercial viability of the turbine system.

N80-28858# Washington State Univ., Pullman.
COMPARISON OF COAL-FIRED POWER SYSTEMS IN
WASTE HEAT APPLICATIONS IN TACOMA, WASHINGTON
M.S. Thesis

Jeremy Robertson 1979 237 p refs (Contract EE-77-S-05-5516)

(TID-29379) Avail: NTIS HC A11/MF A01

The use of the waste stream of heat produced as a by-product of electrical power generation in a coal fired power plant is analyzed. Efficiency gains in the utilization of waste heat, and environmental impact and economic costs are compared for two types of plants supplying waste heat and for a conventional energy supply system that does not make use of waste heat. Small scale modular integrated utility systems plants are compared with a large power plant. The basis of comparision of systems is investment in an equivalent 300 MW of installed capacity. Power plant technologies are described for all systems as are alternative modes of operation. Waste heat utilization is concluded to be advantageous in efficiency of energy conversion as well as in impacts borne, and is economically competitive in most circumstances. Garden apartments as an end use are clearly superior in all categories to single dwellings, E.D.K.

N80-28874# Sandia Labs., Albuquerque, N. Mex. Geothermal Research Div.

MAGMA ENERGY: A FEASIBLE ALTERNATIVE

John L. Colp Mar. 1980 22 p refs (Contract EY-76-C-04-0789)

(SAND-80-0309) Avail: NTIS HC A02/MF A01

A short review of the work performed in connection with the Magma Energy Research Project is provided. Results to date suggest that boreholes will remain stable down to magma depths and engineering materials can survive the downhole environments. Energy extraction rates are encouraging. Geophysical sensing systems and interpretation methods require improvement, however, to clearly define a buried magma source.

N80-28892# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

# REVIEW OF THE CURRENT STATUS OF THE WIND ENERGY INNOVATIVE SYSTEMS PROJECTS

Irwin E. Vas Mar. 1980 77 p refs.

(Contract EG-77-C-01-4042)

(SERI/TP-635-469) Avail: NTIS HC A05/MF A01

Information is presented concerning theoretical and experimental studies on giromili turbines; diffuser augmented turbines; tornado turbines: electrofluid dynamic generators; Madaras rotors; the vortex augmented turbines; and cooling tower thermodynamic cycles.

N80-28996# Oregon State Univ., Corvallis. Dept. of Atmospheric Science.

# VEGETATION AS AN INDICATOR OF HIGH WIND VELOCITY Final Report, 16 Jun. 1978 - 14 Jun. 1979

E. Wendell Hewson, John E. Wade, and Robert W. Baker Jun. 1979 50 p refs

(Contract EY-76-F-06-2227)

(RLO-2227-T24-79/1) Avail: NTIS HC A03/MF A01

Techniques for using two widely distributed species of coniferous trees. Douglas fir and Ponderosa pine, as aids in wind power prospecting are described. The need for the research, the effects of wind on trees, development of the indices of wind deformation and calibration of these indices to the mean annual wind speed are discussed. Results indicate trees can be used to estimate mean annual wind speed and these estimates, although subject to some uncertainty, are sufficiently sensitive to be used as an initial criterion for ranking potential sites in terms of wind power potential prior to instrumention with anemometers.

N80-29300\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

# AIRCRAFT RESEARCH AND TECHNOLOGY FOR FUTURE FUELS

Jul. 1980 229 p refs Symp. held in Cleveland, Ohio, 16-17 Apr. 1980

(NASA-CP-2146; E-398) Avail: NTIS HC A11/MF A01 CSCL

The potential characteristics of future aviation turbine fuels and the property effects of these fuels on propulsion system components are examined. The topics that are discussed include jet fuel supply and demand trends, the effects of refining variables on fuel properties, shekle oil processing, the characteristics of broadened property fuels, the effects of fuel property variations on combustor and fuel system performance, and combuster and fuel system technology for broadened property fuels.

N80-29302\*# Department of Energy, Washington, D. C. OUTLOOK FOR ALTERNATIVE ENERGY SOURCES
Michael E. Card In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 5-9

Avail: NTIS HC A11/MF A01 CSCL 21D

Predictions are made concerning the development of alternative energy sources in the light of the present national energy situation. Particular emphasis is given to the impact of alternative fuels development on aviation fuels. The future outlook for aircraft fuels is that for the near term, there possibly will be no major fuel changes, but minor specification changes may be

possible if supplies decrease. In the midterm, a broad cut fuel may be used if current development efforts are successful. As synfuel production levels increase beyond the 1990's there may be some mixtures of petroleum-based and synfuel products with the possibility of some shale distillate and indirect coal liquefaction products near the year 2000.

N80-29303\*# United Air Lines, Inc., Chicago, III.
CURRENT JET FUEL TRENDS

Paul P. Campbell In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 11-14

Avail: NTIS HC A11/MF A01 CSCL 21D

Data concerning the properties of commercial jet fuels during the period between 1974 and 1979 are discussed. During this period the average aromatics content of fuels increased from 16% to 17.5%. It is evident that the arrival of Alaska North Slope crude in 1977 had a significant impact upon the aromatics content of jet fuel supply at West Coast points with less effect upon the entire United States domestic market. This increase in aromatics has not been accompanied by a corresponding reduction in burning quality as measured by smoke point. There has been a reduction of .6 smoke point on the average. Looking at hydrogen content as a measure of burning quality, the all refinery average calculated hydrogen for 1978 was approximately 13.7%. The relationship between hydrogen content and aromatics content shows a slope of .043% reduction in hydrogen for 1% increase in aromatics.

N80-29304\* Boeing Commercial Airplane Co., Seattle, Wash. AVIATION FUELS OUTLOOK

Albert M. Momenthy In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 15-24

Avail: NTIS HC A11/MF A01 CSCL 21D

Options for satisfying the future demand for commercial jet fuels are analyzed. It is concluded that the most effective means to this end are to attract more refiners to the jet fuel market and encourage development of processes to convert oil shale and coal to transportation fuels. Furthermore, changing the U.S. refineries fuel specification would not significantly alter jet M.G.

N80-29306\*# Exxon Research and Engineering Co., Linden, N. I.

# EFFECT OF REFINING VARIABLES ON THE PROPERTIES AND COMPOSITION OF JP-5

Martin Lieberman and William F. Taylor In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 31-39

(Contract N00140-78-C-1491)

Avail: NTIS HC A11/MF A01 CSCL 21D

Potential future problem areas that could arise from changes in the composition, properties, and potential availability of JP-5 produced in the near future are identified. Potential fuel problems concerning thermal stability, lubricity, low temperature flow, combustion, and the effect of the use of specific additives on fuel properties and performance are discussed. An assessment of available crudes and refinery capabilities is given.

M.G.

N80-29308\* Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

# MILITARY JET FUEL FROM SHALE OIL

Edward N. Coppola In NASA. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 49-57 refs

Avail: NTIS HC A11/MF A01 CSCL 21D

Investigations leading to a specification for aviation turbine fuel produced from whole crude shale oil are described. Refining methods involving hydrocracking, hydrotreating, and extraction processes are briefly examined and their production capabilities are assessed.

M.G.

N80-29324\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio. FUELS RESEARCH: FUEL THERMAL STABILITY OVER-VIEW Stephen M. Cohen *In its* Aircraft Res. and Technol, for Future Fuels Jul. 1980 p 161-168 ref

Avail: NTIS HC AT1/MF A01 CSCL 21B

Alternative fuels or crude supplies are examined with respect to satisfying aviation fuel needs for the next 50 years. The thermal stability of potential future fuels is discussed and the effects of these characteristics on aircraft fuel systems are examined. Advanced fuel system technology and design guidelines for future fuels with lower thermal stability are reported.

R.C.T.

# N80-29327\*# Colorado School of Mines, Golden. MECHANISMS OF NITROGEN HETEROCYCLE INFLUENCE ON TURBINE FUEL STABILITY

Stephen R. Daniel and Jonathan H. Worstell *In NASA*. Lewis Res. Center Aircraft Res. and Technol. for Future Fuels Jul. 1980 p 185-193

(Contract NsG-3122)

Avail: NTIS HC A11/MF A01 CSCL 21D

Lewis bases were extracted from a Utah COED syncrude via ligand exchange. Addition of this extract to Jet A at levels as low as 5 ppm N produced deterioration of stability in both JFTOT and accelerated storage tests (7 days at 394 K with 13:1 air to fuel ratio). Comparable effects on Jet A stability were obtained by addition of pyridine and quinoline, while pyrrole and indole were less detrimental at the same concentration level. The weight of deposit produced accelerated storage tests was found to be proportional to the concentration of added nitrogen compound. Over the narrow temperature range accessible with the experimental method, Arrhenius plots obtained by assuming specific rate to be proportional to the weight of material deposited in seven days exhibit greater slopes in the presence of those nitrogen compounds producing the greater deposition rates. It is shown that despite variation in appearance the elemental composition and spectral characteristics of the deposits are unaffected by addition of the nitrogen compounds. The linearity of the Arrhenius plots and of a plot of Arrhenius slope versus intercept for all the compounds suggests a constancy of mechanism over the range of temperature and heterocycles studied.

N80-29472# Virginia Polytechnic Inst. and State Univ., Blacksburg.

DEVELOPMENT AND APPLICATION OF ANALYTICAL TECHNIQUES TO CHEMISTRY OF DONOR SOLVENT LIQUEFACTION Quarterly Progress Report, Mar. May 1979

A. M. Squires, H. C. Dorn, L. T. Taylor, J. G. Dillard, and P. R. Rony Sep. 1979 34 p refs (Grant EF-77-G-01-2696)

(FE-2696-T4; QPR-7) Avail: NTIS HC A03/MF A01

Major effort concentrated on separation studies of small model compounds and selected fractions of coaly matter via gel permeation chromatography in tetrahydrofuran (THF), chloroform (CHCl3) and pyridine solvents. Molecular weights were determined for materials totally excluded and totally permeated in four soft gels which differ in percent cross-linking. A large number of compounds especially N-alkylated anilines exhibit a nonsize exclusion mechanism of separation. Exclusion limits in pyridine appears to be considerably greater than in THF or CHCl3 for n-alkanes. Results with these soft gels were compared with data obtained on rigid gels. The feasibility of nuclear magnetic resonance (NMR) for the liquid chromatographic detection, functional group analysis via F-19 NMR of select coaly fractions, and liquefaction experiments in our micro-autoclave reactor are discussed.

N80-29502\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SOME ADVANTAGES OF METHANE IN AN AIRCRAFT GAS TURBINE

Robert W. Graham and Arthur J. Glassman 1980 18 p refs Proposed for presentation at Aerospace Congr., Los Angeles, 13-16 Oct. 1980; sponsored by ASAE (NASA-TM-81559; E.520) Avail: NTIS HC A02/ME A01 CSCI

(NASA-TM-81559; E-520) Avail: NTIS HC A02/MF A01 CSCL 21D

Liquid methane, which can be manufactured from any of the hydrocarbon sources such as coal, shale biomass, and organic waste considered as a petroleum replacement for aircraft fuels. A simple cycle analysis is carried out for a turboprop engine flying a Mach 0.8 and 10, 688 meters (35,000 ft.) altitude. Cycle performance comparisions are rendered for four cases in which the turbine cooling air is cooled or not cooled by the methane fuel. The advantages and disadvantages of involving the fuel in the turbine cooling system are discussed. Methane combustion characteristics are appreciably different from Jet A and will require different combustor designs. Although a number of similar difficult technical problems exist, a highly fuel efficient turboprop engine burning methane appear to be feasible. A.R.H.

# N80-29504# Ad-Ex International, Portola Valley, Calif. EXPERIMENTAL STUDIES OF SOME REGULARITIES IN THE UNDERGROUND GASIFICATION OF INCLINED COAL SEAMS

M. K. Revva and E. V. Kreinin Mar. 1980 19 p refs Transl. into ENGLISH from Probl. Podzemn. Gazifikatsii v Kuzbasse USSR (Kemerovo), no. 2, 1967 p 143-153 Sponsored by DOE Prepared for California Univ., Livermore. Lawrence Livermore Lab. (UCRL-Trans-11585) Avail: NTIS HC A02/MF A01

Under natural conditions, the participation of underground water in the gasification process is considerably above the optimum level, and in cola seams 1 and 2 m thick is characterized by a specific water inflow of 1500 to 2500 kg/ton, and by a moisture content of 250 to 400 g/cum in the gas. The combustion heat of the gas in coal seams 1 and 2 m thick (especially in the first case) therefore is significantly below 1000 kcal/cu m under such conditions. The decrease in the combustion heat of the gas with decreasing coal seam thickness is explained by the obvious increase in heat losses to the surrounding rock mass. An increase in the amount of underground water lowers the calorific value still further. The efficiency of gasification of coal seams 8.5, 2, and 1 m thick gradually decreases, being 65 to 70, 55 to 60, and 45 to 50%, respectively. Thus, as the thickness of the coal seam being gasified decreases, one must reduce the involvement of influent underground water in the gasification process. This can be accomplished by increasing the efficiency of the drying of the coal seam being gasified, or by intensifying the gasification process.

N80-29506# Aerojet Energy Conservation Co., Sacramento, Calif. STUDY OF GELLED LNG Final Technical Report

M. I. Rudnicki, J. A. Cabeal, L. C. Hoffman, R. A. Newton, R. K. Schaplowsky, and E. M. VanderWall Jan. 1980 150 p. refs.

(Contract EP-78-C-03-2057)

(DOE/EV-02057/T2) Avail: NTIS HC A07/MF A01

Research involved the characterization of gelled LNG (GELNG) with respect to process, flow, and use properties and an examination of the degree of safety enhancement attainable by gelation. The investigation included (1) an experimental examination of gel properties and gel safety characteristics as well as (2) an analytical study involving the economics and preliminary design of an industrial scale gelation system. The safety-related criterion for successful application of gelled LNG is the substantial reduction of the Maximum Distance to the Lower Flammability Limit, MDLFL. This will be achieved by first, gel-inhibition of the hydrodynamic pooling and spreading of the spill, and second. the suppressed thermal transport properties of the GELNG relative to those of LNG. The industrial scale gelation study evaluated a design capable of producing 11,000 gallons (LNG tank truck) of gel in two hours. The initial assumption that gelation would provide a practical means to enhance safety is supported by the results of this study. Larger scale, comparative spill tests of LNG and GELNG are now required to confirm the safety aspects DOE of use of the gelled material.

N80-29507# Department of Energy, Grand Forks, N. Dak. Grand Forks Energy Technology Center. EFFECT OF OPERATING CONDITIONS ON PRODUCTION

OF LIGHT HYDROCARBON GASES IN SLAGGING FIXED-BED COAL GASIFICATION Jacquelyn K. Olson and Harold H. Schobert 1980 10 p refs (GFETC/RI-80/2) Avail: NTIS HC A02/MF A01

Light hydrocarbon gases - methane through butane - produced during the slagging fixed bed gasification of lightes and subbituminous coals were determined by cryogenic oven gas chromatography using Chromsorb 102 columns. Changing gasification parameters to increase gas residence time, by increasing pressure or decreasing oxygen feed rate, increased the amount of these gases formed. The increased formation of the light hydrocarbons arose from breakdown of coal tars, since the additional amount of gaseous hydrocarbons corresponded well with an observed decrease in tar formation.

N80-29508# Amoco Oil Co., Naperville, III. Research and Development Dept.

CATALYST DEVELOPMENT FOR COAL LIQUEFACTION Final Report, Feb. 1978 - Feb. 1979

D. K. Kim, R. J. Bertolacini, J. M. Forgac, R. J. Pellet, K. K. Robinson, and C. V. McDaniel (Grace (W. R.) and Co., Columbia, Md.) Nov. 1979 355 p refs Sponsored by Electric Power Research Inst.

(EPRI Proj. 408-1; EPRI Proj. 408-2)

(EPRI-AF-1233) Avail: NTIS HC A16/MF A01

Catalysts were developed for liquefaction of high sulfur Eastern coal. A higher severity aging test was employed to ensure that results in the Amoco pilot plant would translate to H-coal operation. Catalyst ranking at the higher severity conditions remained unchanged. The criticality of the bimodal pore distribution was clearly demonstrated with cobalt molybdena catalysts prepared on two essentially identical aluminas but one having essentially no macropore volute. The absence of macropore volume resulted in rapid catalyst deactivation. The liquefaction catalysts were characterized on the basis of reactivity.

N80-29509# SRI International Corp., Menlo Park, Calif. SHIFT CONVERSION AND METHANATION IN COAL GASIFICATION: BENCH-SCALE EVALUATION OF A SULFUR RESISTANT CATALYST Quarterly Progress Report, 1 Jan. - 31 Mar. 1980

B. J. Wood, D. Sheridan, J. G. McCarty, C. M. Ablow, and H. Wise 15 Apr. 1980 18 p refs (Contract ET-78-C-01-3240; SRI Proj. PYU-7930)

(Contract ET-78-C-01-3240; SRI Proj. PYU-7930) (FE-3240-T5) Avail: NTIS HC A02/MF A01

The long term bench scale study previously reported a demonstrated degree of improvement in specific methanation activity, lifetime, and sulfur resistance exhibited by the over a commercial catalyst (Ni/Al2O3). However, quantitative interpretation of the results by measurements of H2S-breakthrough was obscured by the interaction of the particulate alumina diluent with the sulfur poison in the feed stream. To assess the magnitude of this perturbation by the diluent, a series of experimental measurements was performed in smaller reactors containing the catalyst samples without any diluent added to the catalyst bed. In these experiments the decline in the rates of methane production and CO conversion, and the appearance of H2S in the product stream were monitored.

N80-29510# Bechtel International Corp., San Francisco, Calif. PRODUCTION OF SYNTHETIC LIQUIDS FROM COAL, 1980 - 2000. PRELIMINARY STUDY OF POTENTIAL IMPEDIMENTS Final Report

Dec. 1979 264 p refs (Contract ET-78-C-01-3137)

(FE-3137-T1) Avail: NTIS HC A12/MF A01

Potential impediments for the 3 million barrels per day (MMBPD) scenario were identified in the following areas: engineering manpower; manual labor, certain materials and equipment, and plant permits and licenses. Chemical engineers working in this area must be increased by one-third by 1985. Pipefitters, pipefitters-welders, boilermakers, boilermaker-welders and electricians will be in short-supply. In certain regions of the country, 30 to 80 percent of the available manpower in some of these trades will be required by the 3 MMBPD coal liquids program. The availability of 34 categories of material and equipment was assessed in order to identify potential impediments.

The following categories appear to be potentially critical for the 3 MMBPD program: draglines, heat exchangers, pressure vessels, centrifugal compressors, and alloy and stainless steel valves.

DO

N80-29511# Battelle Columbus Labs., Ohio.
CARBOHYDRATE CROPS AS A RENEWABLE RESOURCE
FOR FUELS PRODUCTION. VOLUME 3: JUICE PRESERVATION

D. J. Fink, B. R. Allen, J. H. Litchfield, and E. S. Lipinsky 29 Jan. 1980, 40 p. refs.

1980 40 p refs (Contract W-7405-eng-92)

(BMI-2031-Vol-3) Avail: NTIS HC A03/MF A01

Polysaccharide hydrolysis was investigated as a means for preserving mixed sugar solutions obtained from crops such as sweet sorghum. Experiments conducted were directed to achieve concentration of (1) pure sugar solutions by hydrolysis of purified starch: (2) genuine sugar crop juice by hydrolysis of purified starch: (3) pure sugar solutions by hydrolysis of genuine biomass starch: and (4) pure sugar solutions by hydrolysis of cellulosic materials. Inhibition of the cellobiase component of the cellulase preparation was observed in the experiments. Results demonstrate the feasibility of one approach to the preparation of concentrated, microbiologically stable sugar syrups starting with sweet sorghum juice.

N80-29512# California Univ., Berkeley. Lawrence Berkeley
Lab. Energy and Environment Div.
BIOMASS LIQUEFACTION EFFORTS IN THE UNITED

Sabri Ergun Feb. 1980 23 p (Contract W-7405-eng-48)

STATES

(LBL-10456) Avail: NTIS HC A02/MF A01

Research programs being conducted in the biomass liquefaction are summarized. The facilities in Albany, Oregon and at LBL are described and flowcharts are included. The reactions occuring during these processes are explained. Properties of the oil produced are described.

N80-29513# Suntech, Inc., Marcus Hook, Pa. Research and Engineering Div.

RESEARCH AND DEVELOPMENT OF AN ADVANCED PROCESS FOR THE CONVERSION OF COAL TO SYNTHETIC GASOLINE AND OTHER DISTILLATE FUELS Quarterly Technical Progress Report, Apr. - Jun. 1979

A. Schneider, E. J. Hollstein, E. J. Janoski, and E. G. Scheibel Oct. 1979 28 p

(Contract EX-76-C-01-2306)

(FE-2306-38; QTPR-9) Avail: NTIS HC A03/MF A01

Continuous dimethylformamide (DMF)-heptane extractions of solvent refined coal-2 (SRC-2) were conducted. The data confirm that the extraction column can be operated at suitable conditions to remove any desired amount of coal liquids as extract product. Countercurrent operation of the 33 stage, three inch. baffled, Scheibel extraction column gives exceptionally high throughputs with the DMF-heptane system. Results indicate that: (1) the raffinate products of the 25 to 27% extractions contain 90 wt % aromatic, 0.4 wt % nitrogen, and 0.3 wt % oxygen: (2) hydrodenitrogenation of the raffinate product proceeds at a rate six times faster than nonextracted SRC-2 C to yield a product possibly suitable as a hydrocracker or fluid catalytic cracker feed; and (3) the extract products of the 25% to 27% extractions contain 8 wt % oxygen and 2.5 wt % nitrogen.

N80-29514# Suntech, Inc., Marcus Hook, Pa. Research and Engineering Div.

RESEARCH AND DEVELOPMENT OF AN ADVANCED PROCESS FOR THE CONVERSION OF COAL TO SYNTHETIC GASOLINE AND OTHER DISTILLATE FUELS Quarterly Technical Progress Report, Jan. - Mar. 1979

A. Schneider, E. J. Hollstein, E. J. Janoski, and E. G. Scheibel May 1979 46, p

(Contract EX-76-C-01-2306)

(FE-2306-35: QTPR-8) Avail: NTIS HC A03/MF A01

The feasibility of continuous deep liquid extraction of coal liquids with dimethylformamide (DMF)-heptane is demonstrated.

It is concluded that the use of DMF-heptane is more practical than aqueous tailored to remove any desired amount of coal liquids. The extraction procedure as practiced with either DMF or aqueous methanol does not remove all basic nitrogenous material but successfully removes the phenolic material. Attempts to hydrorefine the highly phenolic extract product causes the evolution of much methane at relatively low temperatures. Catalytic hydrodeoxygenation follow first order kinetics.

N80-29517# Gulf Research and Development Co., Pittsburgh,

INVESTIGATION OF MECHANISMS OF HYDROGEN TRANSFER IN COAL HYDROGENATION Quarterly Progress Report, Jan. - Mar. 1979

D. C. Cronauer, R. G. Ruberto, and D. C. Young May 1979 20 p ref

(Contracts EX-76-C-01-2305; E(49-18)-2305)

(FE-2305-33) Avail: NTIS HC A02/MF A01

The analytical approach to determine the conversion of coal and/or asphaltenes to pentane soluble product (oils) was modified to limit co-solvent effects. To simulate products obtained during the initial stage of liquefaction, hydrogen transfer experiments were done asphaltenes prepared from the low severity liquefaction of Kentucky 9/14 and Illinois No. 6 coals with SRC-2 solvent. The preparation of these asphaltenes was carried out at mild liquefaction conditions of 375 C and 400 C at space times of 5 and 12 minutes. The asphaltenes were used in making an extensive number of hydrogen transfer experiments with various solvents, temperatures and reaction times. The runs were made in the 9 ml micro-reactor which is immersed in a heated sand bath. The average heat-up time is about 2.2 to

N80-29520# Office of Technology Assessment, Washington, D. C.

THE DIRECT USE OF COAL. VOLUME 2, PART A: WORKING PAPERS, APPENDICES 1-4

Nov. 1979 463 p refs

(PB80-184518; OTA-E-86A-Vol-2-Pt-A-App-1-4) Avail: NTIS HC A24/MF A01 CSCL 13B

The contents include: (1) selection topics in estimating future energy deamand and supply, (2) rethinking the scale of coal-fired electric generation: technological and institutional consideration, (3) residential and commercial uses of coal, (4) coal cleaning and desulfurization, (5) direct utilization of coal: fuel gas desulfurization, and (6) miners and operators collective bargaining in coal.

N80-29521# Office of Technology Assessment, Washington,

THE DIRECT USE OF COAL. VOLUME 2, PART B: WORKING PAPERS, APPENDICES 7-9

Dec. 1979 605 p refs (PB80-184526: OTA-E-86B-Vol-2-Pt-B-App-7-9) Avail: NTIS HC A99/MF A01 CSCL 13B

The contents include: (1) environmental considerations for increased coal utilization; (2) transport and fate of sulfur and other air pollutions; and (3) prediction and review of air pollution health effects from direct coal combustion.

N80-29522# Office of Technology Assessment, Washington,

THE DIRECT USE OF COAL. VOLUME 2, PART C: WORKING PAPERS, APPENDICES 10-14

Dec. 1979 542 p refs

(PB80-184534; OTA-E-86C-Vol-2-Pt-C-App-10-14) Avail:

NTIS HC A23/MF A01 CSCL 13B

The contents include: (1) effects on plants of sulfur pollutants from coal combustions; (2) coal mine health; (3) social and economic impacts of coal production in the eastern United States: (4) impacts of coal development of Western communities; and (5) public attitudes toward coal-fired power plants.

N80-29523# Office of Technology Assessment, Washington. D. C.

THE DIRECT USE OF COAL. VOLUME 2, PART D: **WORKING PAPERS, APPENDICES 15-17** 

Dec. 1979 425 p refs (PB80-184542: OTA-E-86D-Vol-2-Pt-D-App-15-17) Avail: NTIS HC A18/MF A01 CSCL 13B

The present state of the Federal coal leasing policy is examined. Abuses and problems associated with prior leasing policies and recent congressional amendments are examined and a number of reforms are suggested. Laws applicable to air emissions from the direct use of coal are cited along with the Surface Mining Control and Reclamation Act of 1977.

N80-29524# Massachusetts Inst. of Tech., Cambridge. Energy Lab.

PEAT AS A FUEL AT THE PROPOSED CENTRAL MARINE POWER COMPANY 600 MW PLANT, VOLUME 1 Final Report

William J. Jones Dec. 1979 184 p refs Sponsored in part by Central Maine Power Co.

(PB80-175185; MIT-EL-79-012-Vol-1) NTIS Avail: HC A09/MF A01 CSCL 10B

The findings and recommendations resulting from an exploratory assessment of the technical feasibility of using peat instead of coal are presented. The economic and institutional issues that may be involved as a result of such a substitution are considered. It is intended for a broad spectrum of readers

N80-29526# Council for Scientific and Industrial Research, Pretoria (South Africa). Chemical Engineering Research Group. PREPARATION AND STABILITY OF EMULSIONS OF METHANOL IN AUTOMOTIVE DIESEL OIL

C. G. McCormack Oct. 1979 35 p refs (PB80-169162; CSIR-CENG-294; ISBN-0-7988-1730-5) Avail: NTIS HC A03/MF A01 CSCL 21D

Short term emulsification of up to 20% methanol in diesel oil (stability lasting a few hours) is feasible but the emulsifiers successful in this respect are costly and have to be applied in relatively high concentrations. No emulsifier was found which produces an emulsion with long term stability; mutual solubilities of the various components and solubility changes with temperature were identified as the most important causes. It is unlikely that an emulsifier will be found which produces stable temperature insensitive emulsions of methanol in diesel oil. Even if such an emulsifier exists the required amount and costs are expected to be prohibitive in a fuel application.

N80-29527# New Mexico Inst. of Mining and Technology,

COORDINATING FOSSIL FUEL RESEARCH IN NATURAL **GAS RECOVERY** 

1979 29 p

(PB80-169469) Avail: NTIS HC A03/MF A01 CSCL 081

Projects that range from studying the State's fossil fuel resources to developing new methods for expanded exploration, improving production techniques, and developing programs which best utilize these resources are reviewed.

N80-29707\*# Phillips Petroleum Co. Europe-Africa, London (England).

FIELD EXPERIENCES WITH ROTORDYNAMIC INSTABILITY IN HIGH-PERFORMANCE TURBOMACHINERY

H. E. Doyle In NASA. Lewis Res. Center Rotordyn. Instability Probl. in High-Performance Turbomachinery 1980 p 3-13 Avail: NTIS HC A20/MF A01 CSCL 131

Two field situations illustrate the consequences of rotordynamic instability in centrifugal compressors. One involves the reinjection of produced gas into a North Sea oil formation for the temporary extraction of crude. The other describes on-shore compressors used to deliver natural gas from off-shore wells. The problems which developed and the remedies attempted in each case are discussed. Instability problems resulted in lost production, extended construction periods and costs, and heavy maintenance expenditures. The need for effective methods to properly identify the problem in the field and in the compressor design stage is emphasized.

N80-29822\*# Stanford Univ., Calif. Dept. of Applied Earth

GEOLOGICAL AND GEOTHERMAL DATA USE INVESTIGA-TIONS FOR APPLICATION EXPLORER MISSION-A (HEAT CAPACITY MAPPING MISSION) Technical Report, 1 Oct. 31 Dec. 1979

R. J. P. Lyon and A. E. Prelat, Principal Investigators 31 Dec. 1979 5 p HCMM

(Contract NAS5-24232)

(E80-10279; · NASA-CR-163345) NTIS Avail:

HC A02/MF A01 CSCL 08B

#### N80-29869# Idaho National Engineering Lab., Idaho Falls. HYDROTHERMAL ENERGY: A SOURCE OF ENERGY FOR **ALCOHOL PRODUCTION**

R. R. Stiger 1980 11 p Presented at the Alcohol Alternative Conf., Chicago, 1 May 1980

(Contracts EY-76-C-07-1570; DE-AC07-761D-01570)

(CONF-800526-1) Avail: NTIS HC A02/MF A01

A small scale (1 gal/hr) biomass-to-alcohol still was built at the Raft River Geothermal Site to investigate difficulties in geothermal assisted biomass conversion. The unit was successfully operated, producing 95% (190 proof) ethanol from sugar beet juice. The unit was designed and built in less than eight weeks from surplus equipment using commercially available design information. This small scale still demonstrated that 95% ethanol can be produced from sugar beet beer containing 8 to 10% alcohol using geothermal energy and present commercial technology. The geothermal energy and present commercial technology. The geothermal resource provided both an energy source and process water. Recently, a study was completed to analyze the economic feasibility of producing ethanol from potatoes, wheats, and sugar beets using geothermal resources available in the Raft River Region of Idaho. The study concluded that a 20 million gallon per year facility can be built that will supply alcohol at \$1.78 per gallon using geothermal energy.

#### N80-30171# Oak Ridge National Lab., Tenn. OVERVIEW OF NUCLEAR FUEL CYCLE

J. O. Blomeke 1979 32 p Presented at the ANS Student Chapter Seminar, College Station, Texas, 5-9 Nov. 1979 (Contract W-7405-eng-26)

(CONF-791185-3) Avail: NTIS HC A03/MF A01

A broad, general look is given at the fuel cycle from an overall perspective. Covered are: boiling water reactors and pressurized water reactors fuel characteristics, U mining and milling, enrichment, fuel fabrication, spent fuel reprocessing, handling and shipment, etc. Results of the International Fuel Cycle Evaluation are summarized. DOE

N80-30313# Pratt and Whitney Aircraft, West Palm Beach, Fla. Government Products Div.

ADVANCED COMBUSTION SYSTEMS FOR STATIONARY GAS TURBINE ENGINES. VOLUME 4: COMBUSTOR VERIFICATION TESTING, ADDENDUM Final Report, Jul. -Oct. 1979

Robert M. Pierce, Clifford E. Smith, and B. S. Hinton Jan. 1980 119 p refs

(PB80-179849; FR-11405-Vol-4; EPA-600/7-80-017D-Vol-4) Avail: NTIS HC A06/MF A01 CSCL 21E

Tests to evaluate the performance of the combustor on heavy fuels such as petroleum or shale residual oil and solvent refined coal (SRC) are described. Results from the tests show that all exhaust emission goals were met while burning three test fuels: a middle-cut distillate SRC, a residual shale oil, and an Indonesian/ Malaysian residual oil. It was also demonstrated that the exhaust emission goals were met when operating a RB/QQ combustor at a high turbine inlet temperature (1426 C design) firing No. 2 fuel oil.

N80-30470# Oklahoma Univ., Norman. School of Aerospace, Mechanical and Nuclear Engineering.

COMBUSTION OF DROPS AND SPRAYS OF NO. 2 DIESEL OIL AND ITS EMULSIONS WITH WATER AND METHANOL. **VOLUME 1: EXPERIMENTAL Final Report, Jul. 1978 -**Aug. 1979

S. R. Gollahalli, M. L. Rasmussen, and S. J. Moussavi Jan. 1980 231 p refs 2 Vol.

(Contract DOT-RC-82011)

(PB80-178213; OU-AMNE-79-15-Vol-1;

DOT/RSPA/DPB-50-80/1-Vol-1)

Avail: HC A11/MF A01 CSCL 21G

The combustion behavior of No. 2 diesel oil and its emulsions with water and methanol is examined experimetally. The experiments are carried out in three parts: a study of stability and microstructure of emulsions, single drop combustion studies, and spray combustion studies. The results show that unsupported drops of No. 2 diesel oil emulsions with water and methanol undergo disruption during combustion and the fragmentation activity depends on emulsion and ambient variables. The ignition and pollutant emission characteristics of No. 2 diesel oil sprays also are seen to be affected by emulsification. GRA

N80-30471# Oklahoma Univ., Norman. School of Aerospace, Mechanical and Nuclear Engineering.

COMBUSTION OF DROPS AND SPRAYS OF NO. 2 DIESEL OIL AND ITS EMULSIONS WITH WATER AND METHANOL. VOLUME 2: THEORETICAL Final Report, Jul. 1978 - Aug. 1979

M. L. Rasmussen and S. R. Gollahalli Jan. 1980 131 p refs 2 Vol.

(Contract DOT-RC-82011)

(PB80-178221: OU-AMNE-79-16-Vol-2:

DOT/RSPA/DPB-50-80/2-Vol-2)

Avail: NTIS

NTIS

HC A07/MF A01 CSCL 21G The combustion behavior of No. 2 diesel oil and its emulsions with water and methanol is analyzed theoretically. Two theoretical models to analyze the variation of drop temperature with emulsion parameters are developed. The differential model considers the diffusion and specific heat effects inside the composite emulsion drop. The integral model does not consider the temperature variation inside the drop. Analytic solutions for both models are developed assuming constant properties. The integral model is also solved numerically considering the variation of properties and using some empirical input data. Both models predict the variation of drop disruption time with the internal phase content in qualitative agreement with the experimentally measured values for the drops of No. 2 diesel oil-water emulsion with water volume fractions up to 0.20.

N80-30535\*# United Technologies Research Center, East Hartford, Conn.

#### AUTOIGNITION CHARACTERISTICS OF AIRCRAFT-TYPE **FUELS**

Louis J. Spadaccini and John A. TeVelde Jun. 1980 88 p refs

(Contract NAS3-20066)

(NASA-CR-159886; R80-914617-1) HC A05/MF A01 CSCL 21D

Avail: NTIS

The ignition delay characteristics of Jet A, JP 4, no. 2 diesel, cetane and an experimental referee broad specification (ERBS) fuel in air at inlet temperatures up to 1000 K, pressures of 10, 15, 20, 25 and 30 atm, and fuel air equivalence ratios of 0.3, 0.5, 0.7 and 1.0 were mapped Ignition delay times in the range of 1 to 50 msec at freestream flow velocities ranging from 20 to 100 m/sec were obtained using a continuous flow test apparatus which permitted independent variation and evaluation of the effect of temperature, pressure, flow rate, and fuel/air ratio. The ignition delay times for all fuels tested appeared to correlate with the inverse of pressure and the inverse exponent of temperature. With the exception of pure cetane, which had the shortest ignition delay times, the differences between the fuels tested did not appear to be significant. The apparent global activation energies for the typical gas turbine fuels ranged from 38 to 40 kcal/mole, while the activation energy determined for cetane was 50 kcal/mole. In addition, the data indicate that for lean mixtures, ignition delay times decrease with increasing equivalence ratio. It was also noted that physical (apparatus dependent) phenomena, such as mixing (i.e., length and number

of injection sites) and airstream cooling (due to fuel heating, vaporization and convective heat loss) can have an important effect on the ignition delay.

N80-30538# Institute of Gas Technology, Chicago, III. PROCESS EVALUATION: STEAM REFORMING OF DIESEL FUEL OIL Final Technical Report, 24 Apr. - 24 Dec. 1979 George A. Jarvi, Ronald M. Bowman, Elias H. Camara, and Anthony L. Lee 15 Feb. 1980 51 p refs (Contract DAAK70-79-C-0048)

(AD-A087053) Avail: NTIS HC A04/MF A01 CSCL 21/4 This project is an evaluation of a proprietary catalyst as a means of steam-reforming diesel fuel oil (Fed. Spec. VV-F-800B, symbol DF-2). A system for testing the catalyst has been designed, built and successfully used to screen operating conditions of temperature, space velocity, and H2O/C ratio. A duration test has been conducted showing the catalyst capable of steam reforming diesel fuel, but with the production of naphthalene after 30 hours. Hydrogen production remained stable through the 86 hours of the test.

N80-30540# Rockwell International Corp., Canoga Park, Calif Energy Systems Group.

PARTIAL LIQUEFACTION OF COAL BY DIRECT HYDRO-GENATION Quarterly Progress Report, Oct. - Dec. 1979 A. Y. Falk 1980 38 p

(Contract EX-76-C-01-2044)

(FE-2044-51) Avail: NTIS HC A03/MF A01

Fifteen additional reactor tests with an average duration of 1 hour each were made in the 1 TPH process development unit (PDU). The water cooled heat recovery quench unit was employed for all these tests. In general, operation of the PDU is progressing smoothly. No significant operational/hardware problems were encountered. The new product recovery system and heat recovery quench unit appear to be functioning well and as designed. Analysis of results from the tests conducted employing the heat recovery quench unit indicates carbon. conversion results that are consistent with the results of the previous testing. Tables summarizing the test conditions and carbon conversion results, product gas compositions, and liquids (heavy and light oils) properties are presented.

N80-30541# Brigham Young Univ., Provo, Utah. ALLOY CATALYSTS WITH MONOLITH SUPPORTS FOR METHANATION OF COAL-DERIVED GASES Quarterly Technical Progress Report, 21 Jun. - 20 Sep. 1979

Calvin H. Bartholomew 5 Oct. 1979 40 p refs (Contract EF-77-S-01-2729)

(FE-2729-8) Avail: NTIS HC A03/MF A01

Kinetic studies of monolithic Ni/Al2O3 revealed a shift in activation energy for methanation of CO above 573 K. In kinetic studies at high pressure rapid deactivation-was observed for low loading monolithic catalysts. A one dimensional computer model for methanation over monolithic catalysts was developed to provide insight into experimental conversion vs. temperature data taken in this laboratory. A method for qualitatively determining sulfur on poisoned catalysts was developed and tested. Metal crystallite size distribution data obtained from transmission electron micrograph (TEM) studies on Ni/silica catalysts suggest that sintering may occur by both crystallite and atomic migration mechanisms. The TEM studies of 3% Ni/TiO2 reveal the presence of raft-like crystallites. These and other accomplishments are reported and discussed.

N80-30543# Puerto Rico Univ., Rio Piedras. Center for Energy and Environment Research.

PRODUCTION OF SUGARCANE AND TROPICAL GRASSES AS A RENEWABLE ENERGY SOURCE Quarterly Reports, 1 Jun. - 30 Nov. 1979

A. G. Alexander . 1979 73 p refs

(Contracts ET-78-S-05-5912: DE-AS05-78ET-20071)

(ORO-5912-T3; AES-UPR-C-481; QR-1/2) Avail: NTIS HC A04/MF A01 -

The principal yield trends for biomass included: (1) increased yields with delay of harvest frequency; (2) lack of response to

narrow row spacing; and (3) lack of appreciable yield differences between varieties when allowed to reach maturity. First ratoon yields for both sugarcane and napier grass significantly exceeded the plant crop yields. For sugarcane, the average production of millable cane was 88.6 tons/acre year. Total dry matter (including trash) averaged 33.6 tons/acre year. Second year yield increases consisted largely of dry matter (32%) as opposed to green material (18%). The highest napier grass yields were about 91 green tons and 33 dry tons/acre year, approximately 29% and 35% higher than the year 1 output. Production costs for sugarcane amounted to \$25.46/oven-dry ton, or about \$1.70/million BTUs. Puerto Rico is presently paying around \$4.00/million BTUs in the form of imported bunker C residual oil. Sucrose yields were quite low, averaging 6.6%, but total fermentable solids were comparable to the commercial sugarcane yields in Puerto Rico.

N80-30544# Chevron Research Co., Richmond, Calif. REFINING AND UPGRADING OF SYNFUELS FROM COAL AND OIL SHALES BY ADVANCED CATALYTIC PROCESSES. LABORATORY AND PILOT PLANT STUDIES OF THE PROCESSING OF SRC-1 Interim Report

R. F. Sullivan, B. E. Stangeland, H. C. Chen, and C. E. Rudy Nov. 1979 80 p (Contract EX-76-C-01-2315)

(FE-2315-45; IR-2) Avail: NTIS HC A05/MF A01

Solvent refined coal (SRC) from the SRC-1 process is a high melting solid material that contains large amounts of nitrogen, oxygen, and metallic contaminants and is low in hydrogen content. It is a feed that is extremely difficult to convert to transportation fuels in high yields using commercial fixed bed, catalytic hydroprocessing technology. It was demonstrated that SRC 1 can be hydrotreated in the presence of a coal derived solvent at moderate cracking conversions (e.g., 50% conversion to material boiling below 850 F) for at least 1000 hours without serious plugging of the catalyst bed. However, even at these relatively low conversion levels, catalyst deactivation rates are unacceptably high. With higher severity hydroprocessing, high conversion can be obtained and most of the heteroatoms can be removed. However, severe plugging occurs in the catalyst beds in a short period of time. We do not regard conversion of SRC-1 to transportation fuels by the routines here as being commercially feasible. DOE

N80-30545# UOP, Inc., Des Plaines, III. UPGRADING OF COAL LIQUIDS: HYDROCRACKING OF EDS PROCESS DERIVED GAS OILS Interim Report Frederick J. Riedl and Armand J. DeRosset Nov. 1979 120 p (Contract EF-77-C-01-2566) (FE-2566-33) Avail: NTIS HC A06/MF A01

The applicability of commercial UOP catalysts and processes for hydrocracking coal derived distillates, produced by the Exxon Donor Solvent (EDS) process was evaluated. Process conditions within commercial ranges were selected to produce either fuel oil or gasoline. Hydrocracking was done in two stages. When operating in the gasoline mode, the first stage produced a high nitrogen product to be used in a series flow, two reactor, second stage hydrocracking process. When operating in the fuel oil mode, first stage operation produced a low nitrogen product to be used in a single reactor second stage hydrocracking process. The volumeric yields of C5(+) gasoline and butanes from the gasoline mode operation ranged from 105 to 115.5% and 18 to 26%, respectively. The octane number of the C5(+) gasoline ranged from 75 to 83 RON clear. The overall hydrogen consumption ran from 3300 to 4200 SCF/bbl, all of which can be supplied by reforming the gasoline and steam reforming the C1 to C4 gases. In the fuel oil mode, yield of environmentally acceptable distillate was about 88%.

N80-30547# Mobil Research and Development Corp., Paulsboro, N. J. Processes Research and Technical Service Div. UPGRADING OF COAL LIQUIDS FOR USE AS POWER **GENERATION FUELS Final Report** 

P. J. Angevine, M. Becker, R. B. Callen, M. J. Dabkowski, M. P. Granchi, L. A. Green, R. H. Heck, C. A. Simpson, S. S. Shih,

and T. R. Stein Dec. 1979 247 p refs Sponsored by Electric Power Research Inst. (EPRI Proj. 361-2)

(EPRI-AF-1225) Avail: NTIS HC A11/MF A01

Residual coal liquids were hydroprocessed in fixed bed unit to upgrade them to power generation fuels. A series of catalysts was evaluated for the desulfurization of short contact time (SCT) Solvent Refined Coal (SRC). Low sulfur (0.4 wt %) boiler fuels were produced with hydrogen consumptions as low as 800 and 1200 scf/B from Indiana 5 regular SRC and W. Kentucky SCT SRC, respectively. Constant temperature aging runs were conducted with both regular and short contact time SRC. A kinetic aging model was developed to estimate process conditions and yields in either a fixed bed or ebullated bed reactor. Chemical characterization indicated that W. Kentucky SCT SRC molecules are significantly larger and more polar than those of Indiana 5 regular SRC. The high conversion of asphaltenes to less polar material does not appear necessary for SRC desulfurization.DOE

N80-30548# Westinghouse Electric Corp., Madison, Pa. Advanced Coal Conversion Dept.

ADVANCED COAL GASIFICATION SYSTEM FOR ELECTRIC POWER GENERATION Quarterly Progress Report, 1 Oct. - 31 Dec. 1978

H. K. Altiner, M. J. Arthurs, E. J. Chelen, P. Cherish, Z. F. Hudson, S. Katta, D. L. Keairns, L. K. Rath, N. D. Rohatgi, L. A. Salvador et al. 30 Jun. 1979 137 p. ref (Contract EF-77-C-01-1514)

(FE-1514-97) Avail: NTIS HC A07/MF A01

The operation of the PDU focused on testing of the single stage gasifier system using numerous coal feedstocks and oxygen and steam as the gasification media. Operating summaries with the significant results of these tests are described. Test TP-018-5 was the last shakedown test in an experimental test grid with highly caking Pittsburgh seam coal. This test grid was designed to show the effects of varying the oxygen and steam flows on the higher heating value of the product gas on a dry basis. In addition, a slight modification to the oxidant tube geometry was examined during this test as well as in tests TP-019-1 and TP-019-2. The operability of the oxygen blown gasifier on more highly reactive feedstocks was explored in the TP-019 test series. Three coals successfully gasified ranged from Montana Rosebud sub-bituminous coal to two highly volatile bituminous B rank coals: Indiana No. 7 and Western Kentucky No. 9.

N80-30549# Utah Univ., Salt Lake City. Dept. of Mining and Fuels Engineering.

APPLIED RESEARCH AND EVALUATION OF PROCESS CONCEPTS FOR LIQUEFACTION AND GASIFICATION OF WESTERN COALS Quarterly Progress Report, Jul. - Dec. 1979

Wendell H. Wiser Mar. 1980 12 p refs (Contracts EX-76-C-01-2006; E(49-18)-2006) (FE-2006-17) Avail: NTIS HC A02/MF AQ1

The experimental work on coal dissolution in hydrogen donor solvents was completed. The data are analyzed and interpreted to explain the major structural features of each high volatile bituminous coal examined. The findings are related to the heterogeneity, polymeric nature, aromaticity, aromatic cluster size and distribution of the clusters in the coal. The results are specific to the particular coal, but agree generally with the current understanding of coal structure. The effects of pressure, temperature, and contact time on sulfur removal were determined at a constant hydrogen/oil feed ratio of 5000:1 std cc H2/cc oil one specific catalyst bed weight (equivalent stationary bed heights of about 5 in.) and one catalyst particle size (49 micron average diameter). Within the chosen operating range, the SRC allowed smooth and stable operation of the fluid bed without any agglomeration of the catalyst particles. Some typical results are shown.

N80-30551# Argonne National Lab., III. Materials Science Div.

MATERIALS TECHNOLOGY FOR COAL-CONVERSION PROCESSES Progress report, Jul. - Dec. 1979

1980 95 p refs (Contract W-31-109-eng-38)

(ANL-80-12: PR-19) Avail: NTIS HC A05/MF A01

Analysis of refractories exposed to slag attack during the last 500 h test run shows that complex spinels formed at the slag refractory interfaces of the chrome-spinel, alumina-chromia, and alumina refractories. Silicon carbide refractories reacted with iron oxides and produced a low melting ferrosilicon alloy and CO or CO2 gas. A high temperature ultrasonic erosion scanner was installed and field tested at the Solvent Refined Coal (SRC) coal liquefaction plant. Automatic data acquisition was accomplished through direct coupling to the SRC on site computer. The scanner has detected erosive wear in the SRC erosion corrosion test loop. Results suggest that as exposure time increases, a greater oxygen partial pressure is required for breakaway corrosion. Synergistic erosion corrosion studies conducted in a simulated coal gasification atmosphere at 815 C, with 150 Al2O3 at 22 m/s as erodant, show that Incoloy 800 was the most corrosion resistant alloy tested and 1015 carbon steel the least resistant. DOE

N80-30552# Gilbert Associates, Inc., Reading, Pa.
RESEARCH AND EVALUATION OF BIOMASS RESOURCES/
CONVERSION/UTILIZATION SYSTEMS (MARKET/
EXPERIMENTAL ANALYSIS FOR DEVELOPMENT OF A
DATA BASE FOR A FUELS FROM BIOMASS MODEL)
Quarterly Technical Progress Report, 1 Nov. 1979 - 31 Jan.
1980

Yong K. Ahn, Yung C. Chen, Herbert T. Chen, Richard W. Helm, Eric T. Nelson, Kevin J. Shields, Richard P. Stringer, and Richard C. Bailie (West Virginia Univ., Morgantown) 1980 106 p (Contracts ET-78-C-02-5022; DE-AC02-78ET-20611) (DDE/ET-20611/11) Avail: NTIS HC A06/MF A01

The biomass allocation model was developed and is undergoing testing. Data bases for biomass feedstock and thermochemical products are complete. Simulated data on process efficiency and product costs are being used while more accurate data are being developed. Process models for entrained bed and fixed bed gasifiers based on coal were adapted to biomass. Conceptual economics were generated for seven of the fourteen process configurations via a biomass economic computer program. Pulse tests in a fluidized bed to determine the effect of particle size on reaction rates and product gas composition were completed. Two hour shakedown tests using peanut hulls and wood as the biomass feedstock and the fluidized bed reactor mode were carried out. A comparison was made of the gas composition using air and steam. To date approximately 70 biomass types were collected. Thermal gravimetric, pyrogaschromatographic and effluent gas analysis were began on pelletized samples of these biomass species. . DOE

N80-30554# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

MOLTEN SALT COAL GASIFICATION PROCESS DEVELOP-MENT UNIT Quarterly Technical Progress Report, Apr. Jun. 1979

M. H. Slater 30 Sep. 1979 56 p (Contract EF-77-C-03-1429)

(SAN-1429-52; QTPR-13) Avail: NTIS HC A04/MF A01

The design, construction, and operation of a process development unit (PDU) which will convert 1 ton of coal per hour into low Btu gas is described. The third successful gasification run was performed. The solids feed system, the combustion air system, the gasifier/quench system, the ash removal system; the sulfur removal system, and the sodium carbonate regeneration system were all operated simultaneously as a single, integrated unit. The gasifier was operated at atmospheric pressure for a total of 272 continuous hours. Gas was produced with an average HHV of 88.6 Btu/scf while gasifying coal at a rate of 400 lb/hr.

N80-30556# Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.
SECOND PHASE OF A COALBED METHANE EXTRACTION AND UTILIZATION PROGRAM

Apr. 1980 140 p. (Contract DE-AC21-78MC-08332) (AESD-TM-3026) Avail: NTIS HC A07/MF A01

The coalbed site was further explored to improve its definition as a methane fuel reservoir and to develop the design of a system capable of providing a large scale demonstration of the recovery of coalbed methane and utilization of it in an industrial application, i.e., process heat and electric power. Three new wells were cored and drill stem testing was conducted on two of them. The site was evaluated as containing 7960 mcf of coalbed methane per acre. The producing well, previously developed, continued in operation except for brief periods of shutdown for equipment maintenance. The well attained a peak flow rate of 85.3 mcf/day and an average daily flow rate in excess of 38 mcf.

N80-30557# Battelle Columbus Labs., Ohio.
THERMOPHYSICAL PROPERTIES OF COAL LIQUIDS
Quarterly Technical Status Report, 1 Oct. - 31 Dec. 1979
J. W. Droege and S. P. Chauhan 21 Jan. 1980 9 p
(Contract DE-AC01-79ET-14941)
(BMI-2043; QTSR-1) Avail: NTIS HC A02/MF A01

Certain physical properties of coal solvent slurries are to be determined as these slurries undergo dissolution reactions. The properties are viscosity, thermal conductivity, density, heat of reaction, and specific heat. Development of an experimental plan was completed and some of the needed equipment was placed on order. Exploratory viscosity measurements were made, showing the need for several modifications and disclosing the nature of the stirring difficulties to be anticipated.

N80-30558# Argonne National Lab., III.
US DEPARTMENT OF ENERGY'S METHANE FROM
LANDFILLS PROGRAM

Michael L. Wilkey 1979 10 p Presented at the Biogas and Alc. Production Conf., Chicago, 25 Oct. 1979 (Contract W-31-109-eng-38)

(CONF-7910126-1) Avail: NTIS HC A02/MF A01

Energy savings and recovery from urban waste streams through participation in the development, evaluation, and implementation of the technologies necessary for recovery, processing, and utilization of combustible gases generated in landfills are considered. The feasibility of landfill gas recovery and use, as well as future optimization techniques and methods, are examined.

N80-30753# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

DEVELOPMENT OF HIGH-TEMPERATURE TURBINE SUBSYSTEM TECHNOLOGY TO A TECHNOLOGY READINESS STATUS, PHASE 2 Quarterly Report, Jan. - Mar. 1980

M. W. Horner May 1980 77 p refs (Contract EX-76-C-01-1806)

(FE-1806-86) Avail: NTIS HC A05/MF A01

Progress in the development of a coal derived low BTU gas fueled high temperature, 2600 to 3000 F firing temperature, gas turbine for use in a combined cycle power plant is reported. Information is included on component design and testing, materials testing, and evaluation of the commercial viability of the gas turbine system.

DOE

N80-30758# Virginia Polytechnic Inst. and State Univ., Blacksburg. Coll. of Engineering.

PERFORMANCE OF A DIESEL ENGINE OPERATING ON RAW COAL-DIESEL FUEL AND SOLVENT REFINED COAL-DIESEL FUEL SURFILES Final Report

H. P. Marshall Mar. 1980 129 p refs (Contract ET-78-S-01-3288)

(CONS-3288-T6) Avail: NTIS HC A07/MF A01

Performance tests using an 11 kW single cylinder diesel engine were made to determine the effects of three different micronized coal fuel oil slurries being considered as alternative fuels. Slurries containing 20, 32, and 40% wt micronized raw coal in no. 2 fuel oil were used. Results are presented indicating

the changes in the concentrations of SO sub X and NO sub X in the exhaust, exhaust opacity, power and efficiency, and in wear rates relative to operation on fuel oil no. 2. The engine was operated for 10 hours at full load and 1400 rpm on all fuels except the 40% wt slurry. This test was discontinued because of extremely poor performance.

N80-30904# IIT Research Inst., Chicago, III.
NAVY-NEW HAMPSHIRE WIND ENERGY PROGRAM Final
Report, 4 Jun. - 31 Oct. 1979

S. A. Bortz, R. A. Budenholzer, R. D. Carlson, I. Fieldhouse, and J. Kornfeld Nov. 1979 264 p refs Supersedes IITRI-D6169 (Contract N00014-79-C-6503)

(AD-A086506: IITRI-M6052: IITRI-D6169) Avail: NTIS HC A12/MF A01 CSCL 10/2

This program investigated the potential of the Mt. Washington, New Hampshire area for generating electric power from wind energy as an alternative to fossil fuels. The U.S. Naval Shipyard at Portsmouth, New Hampshire is among those facilities which could benefit initially from successful wind generated power. IIT Research Institute (IITRI) specialists performed the following tasks (1) Evaluation of New Hampshire's wind energy resources for potential electric power generation using meteorological, topographical, biological and other available information, (2) Assessment of the environmental, social, technical, and other possible barriers to the development of wind energy resources, and (3) Economic evaluation of installing one or more wind turbine generators to supply power either directly to the Shipyard or to lines of the Public Service Company of New Hampshire which supplies the Shipyard.

N80-30909# Physical Sciences, Inc., Woburn, Mass.
COAL PROCESSING FOR FUEL CELL UTILIZATION.
TASK 11: FLUIDIZED BED COAL GASIFICATION MODEL;
DATA ANALYSIS AND PREDICTIONS

Michael L. Finson Jan. 1980 69 p refs (Contract EW-78-A-21-8450)

(METC-8450-T1; TR-209) Avail: NTIS HC A04/MF A01

Development and application of a computational model for fluidized bed gasification of coal is described. A two phase bubbling bed reactor model accounts for the development of bubbles, clouds, and emulsion, with a new statistical treatment to predict bubble size. Coal char reactivity is described in detail, using models for carbon heterogeneous chemistry, pore structure, and mass transport previously developed. Volatile release is handled in a semiempirical manner, and potential gas phase reactions between fuel and oxygen in the bubbles are allowed. The data imply larger gas by passing and particle carry over than predicted, and the computed performance exceeds that observed. The computer program was exercised to map out gasifier performance over a range of conditions. It is shown that proper fluidization often requires more gas flow than can be accommodated chemically, due to limited kinetics and mass transport.

N80-30922# Department of Energy, Washington, D. C. Div of Central Solar Technology.

REPORT OF THE 6TH OCEAN THERMAL ENERGY CONVERSION CONFERENCE. OCEAN THERMAL ENERGY FOR THE 1980'S

Gordon L. Dugger, ed. 1979 543 p refs Conf. held in Washington, D.C., 19 Jun. 1979 Prepared in cooperation with the Applied Physics Lab., Johns Hopkins Univ., Laurel, Md. (CONF-790631-1) Avail: NTIS HC A23/MF A01

For the United States, four ocean energy technologies offer significant promises: Ocean Thermal Energy Conversion (OTEC) (using heated surface waters), wave power, ocean currents, and salinity gradients. An overview of the DOE program for these four technologies is presented in terms of plans, concept descriptions, projected market penetration, and potential institutional barriers to implementation. The OTEC program presently receives about 95% of the total ocean energy systems funds. Up to 2 Quads (2 x 1,000,000,000,000 Btu/yr fuel equivalent or approximately 22 GW(e) of average OTEC power output) is practically achievable by the year 2000, dependent only on the

commercialization strategy employed after the demonstration plant. DOE

N80-30929# Ames Lab., Iowa. Dept. of Chemical Engineering.

### PROCESSES TO INCREASE UTILIZATION OF POWER SOLID WASTES

M. J. Murtha and G. Burnet 1979 18 p refs Presented at the ASCE Power Res. Council/Elect. Power Res. Inst. Workshop, San Diego, Calif., 23 Apr. 1979

(Contract W-7405-eng-82)

(ISM-245; CONF-790499-3) Avail: NTIS HC A02/MF A01 Two processes are being developed for extracting metals from fly ash, limestone, and soda ash is sintered and the alumina extracted from the clinker using a dilute sodium carbonate solution. Recoveries of over 90% are obtained from both bituminous and subbituminous coal ashes, and the calcium silicate residue can be used as a raw material for cement. The second metals recovery method involves high temperature chlorination of the ash in the presence of a reductant in an equilibrium fixed bed or fludized bed reactor. Several metals are recovered as chlorides. Ash feed preparation for both processes includes magnetic separation of an iron-rich fraction which shows promise as a heavy media material or an iron ore. It is expected that at least one of the processes will work on other coal wastes such as fluidized bed combustion residue, coal gasification and liquefaction wastes, and limestone scrubber sludge.

N80-30951# Austrian Solar and Space Agency, Vienna. Abteilung Sonnenenergie.

REGENERATIVE ENERGY SOURCES FOR THE PRODUCTION OF LOW TEMPERATURE HEAT: ENERGY SOURCES, ENERGY TYPES, AND ENERGY CONVERSION; RESULTS AND APPLICATIONS; MEASURES TO PROMOTE USE [REGENERATIVE ENERGIEQUELLEN ZUR ERZEUGUNG VON NIEDERTEMPERATURWAERME. ENERGIEQUELLEN, ENERGIEFORMEN UND ENERGIEUMWANDLUNG; ANWENDUNGEN UND ERFAHRUNGEN; FOERDERUNGSMASSNAHMEN]

Gerhard Faninger and Manfred Bruck 1979 123 p refs In GERMAN: ENGLISH summary

(ISBN-3-7041-0038-2) Avail: NTIS HC A06/MF A01; Austrian Solar and Space Agency, Vienna Sch 25

The experience gained so far concerning the utilization of regenerative energy sources is summarized. Advantages and disadvantages of various systems for the production of low temperature heat are analyzed and recommendations are made for applications regarding hot water production, heating of swimming pools, and space heating. The mechodology of the planning of solar facilities is presented, in addition to a description of the basics of solar technologies. The importance of the utilization of regenerative energy sources is underlined through the presentation of the development of energy management in Austria. The necessity of pursuing measures to accelerate market introduction of solar technology is stressed. A survey of the present measures undertaken for the promotion of solar techniques is given.

N80-30952# Acurex Corp., Mountain View, Calif. Energy and Environmental Div.

PILOT SCALE COMBUSTION EVALUATION OF WASTE AND ALTERNATE FUELS, PHASE 3 Final Report, Feb. - Aug. 1978

R. A. Brown and C. F. Busch Mar. 1980 227 p refs (Contract EPA-68-02-1885)

(PB80-177413: EPA-600/7-80-043) Avail: NTIS HC A11/MF A01 CSCL 13B

The results of three studies which evaluated the combustion of waste products and alternate fuels are presented. The first evaluated a distributed air staging concept for NOx control in pulverized coal fired systems. The second evaluated combustion control techniques and NO emissions when firing coal/oil mixtures. The third evaluated emissions and combustion characteristics of refuse derived fuel (RDF) cofired with either natural gas or pulverized coal.

N80-31499# Northwestern Univ., Evanston, III. Dept. of Mechanical Engineering.

COMBUSTION STUDIES OF COAL-IN-OIL DROPLETS Final Report. 1 Aug. 1977 - 31 Jul. 1979

Report, 1 Aug. 1977 - 31 Jul. 1979 C. K. Law Dec. 1979 60 p refs (Contract DE-FG01-77ET-10660)

(DOE/ET-10660/1) Avail: NTIS HC A04/MF A01

The combustion characteristics of droplets of coal-oil mixtures (COM) were investigated both theoretically and experimentally. The agglomeration of the coal powder occurs upon complete implications regarding radiation transfer, total burning time, and particulate collection efficiency. Agglomeration is somewhat irrelevant for COM with no. 6 oil because of the small volatility differentials between coal and no. 6 oil. As a result of agglomeration, fine-crushing the coal is unnecessary unless they can be reduced to micron-sizes such that agglomerate ignition is facilitated.

N80-31502# Brigham Young Univ., Provo, Utah.
INVESTIGATION OF SULFUR-TOLERANT CATALYSTS FOR
SELECTIVE SYNTHESIS OF HYDROCARBON LIQUIDS
FROM COAL-DERIVED GASES Quarterly Technical Progress
Report, 18 Sep. - 18 Dec. 1979

Calvin H. Bartholomew 10 Jan. 1980 24 p refs (Contract DE-AC01-79ET-14809)

(FE-14809-1) Avail: NTIS HC A02/MF A01

Silica-supported cobalt and iron catalysts were prepared by simple impregnation to incipient wetness with aqueous metal salt solutions. Several impregnations were necessary to ensure a uniform deposition of the metal salt, each followed by intermediate drying. After the final impregnation, the catalysts were dried. These dried samples were then bulk reduced in flowing hydrogen. The reduced catalysts were next passivated with 1% air in nitrogen and crushed to a fine powder for use. The cobalt boride on alumina catalyst was prepared under an N2 blanket in a sealed reaction vessel to avoid the formation of boron oxide. Enough alumina was used so that if all the cobalt adhered to the support 18 wt% metal loading would result.

N80-31503# Wayne State Univ., Detroit, Mich. Coll. of Engineering Energy Center.

ULTRASONIC CHARACTERIZATION OF COAL LIQUEFACTION PRODUCTS Final Report, 11 Apr. 1979 - 11 Feb. 1980

Charles B. Leffert, Leo Weisman, and Diane Moore 29 Feb. 1980 75 p refs

NTIS

(Contract DE-AC22-79PC-10346)

(DOE/PC-10346/1: CEEC-80-1203-1) Avail: HC A04/MF A01

The Wayne State University ultrasonic device and technique was used successfully to calibrate coal derived 0 to 45% wt% asphaltene in oil mixtures (2 wt% increments) for transmitted signal strength versus temperature (25 to 100 C). Computer aided cross plots of the transmitted signal strength versus concentration of asphaltene showed that a wide range of concentration and temperature exists where the viscosity dominated (lower temperature) sound absorption is such that a single valued number for the concentration of the asphaltene can be obtained from measurement of the sample temperature and transmitted signal strength and thus obtain a measure of the quality of the coal-derived product. It is concluded that there is an excellent expectation that the Wayne State ultrasonic device and technique could be used to simultaneously measure (on line) the suspended particle concentration as well as the quality of the coal-derived product.

N80-31506# Mound Lab., Miamisburg, Ohio.

AUTOMATÉD MULTI-SAMPLE GAS CHROMATOGRAPHIC ANALYSIS OF FOSSIL FUEL GASES

Daniel R. Rohler, Gary L. Young, and Victoria M. Franchetti
11 Jun. 1980 21 p ref
(Contract DE-AC04-76DP-00053)

(MLM-2721) Avail: NTIS HC A02/MF A01

Fully automated gas chromatographic analysis of multiple Fischer Assay retort gas samples was achieved. The system used included a commercially available microprocessor controlled gas

chromatograph fitted with an inhouse designed and constructed automated gas sampling rack. This system unattended duplicate analysis of four samples and one standard; the total output of analyses per day was twice that using manual operation. Automation of the rack was achieved through microprocessor control of four time programmable contact closures which operate a set of valves and a printer for sampling, regulating, and recording manifold pressure. Accuracies and precisions using the gas chromatograph sampling rack automatically were comparable to those achieved during manual operation.

N80-31627# Department of Energy, Bartlesville, Okla. , Energy Technology Center.

AVIATION TURBINE FUELS, 1979

Elia Mae Shelton May 1980 15 p. refs (DOE/BETC-PPS-80/2) Avail: NTIS HC A02/MF A01

Properties of some aviation turbine fuels marketed in the United States during 1979 are presented. The samples represented were typical 1979 production and were analyzed in the laboratories of 17 manufactuers of aviation turbine (jet) fuels. The data were submitted for study, calculation, and compilation.

N80-31628# California Univ., Berkeley. Lawrence Berkeley

MULTIPHASE REACTOR MODELING FOR ZINC CHLORIDE CATALYZED COAL LIQUEFACTION M.S. Thesis

Peter James Joyce Apr. 1980 107 p refs (Contract W-7405-eng-48)

(LBL-9870) Avail: NTIS HC. A06/MF A01

A generalized reactor design was presented for a low temperature, coal conversion method, where coal was slurried in an 83 wt % zinc chloride methanol melt and allowed to react at moderate conditions of 275 deg C and 600 psi hydrogen. In the reactor, the slurried melt flowed downward in plug flow on the order of 1 foot per minute through a distance of 15 feet. Liquid mass-transfer studies with the model were undertaken to examine specific effects of zinc chloride in a viscous medium, in order to determine the rate-limiting step in the overall hydrogen absorption rate. The absorption rate can be expressed in terms of a resistance-in-series model. The use of zinc chloride introduces no new effects and the chemical reaction rate of the coal particle is controlling.

N80-31629# Chevron Research Co., Richmond, Calif. REFINING AND UPGRADING OF SYNFUELS FROM COAL AND OIL SHALES BY ADVANCED CATALYTIC PROCESSES Quarterly Report, Oct. - Dec. 1979
R. F. Sullivan and D. J. Orear Jan. 1980 43 p refs

(Contract EX-76-C-01-2315)

(FE-2315-48) Avail: NTIS HC A03/MF A01

Current pilot plant results are presented for processing of H-Coal whole process product derived from Illinois No. 6 coal first, hydrotreating of the whole oil and, second, extinction recycle hydrocracking of the hydrotreated product. The 250F+ portion of severely hydrotreated Illinois H-Coal whole process product meets the jet fuel specifications for aromatics content, smoke, freeze, and flash points and almost meets the current specification for gravity and end point. The yield of 250F+ product is 90.4LV% based on feed. The diesel fuel oxidation stability of, 300F+ hydrotreated products is excellent, even without additives. A large batch of low aromatic, denitrified Illinois H-Coal whole process product was prepared for downstream hydrocracking. In this preparation roughly 2100 SCF/bbl of hydrogen was consumed by the oil. The whole product from this hydrotreater was then cracked in an extinction recycle hydrocracker to make a 350F product. In this hydrocracking step, an additional 800 SCF/bbl of hydrogen was consumed by the oil.

N80-31630# Institute of Gas Technology, Chicago, III. PIPELINE GAS FROM COAL: HYDROGENATION (IGT HYDROGASIFICATION PROCESS) Interim Report, 1 Jul. 1977 - 30 Jun. 1978

May 1980 384 p refs

(Contracts EX-76-C-01-2434; EF-77-C-01-2434;

E(49-18)-2434; Proj. 9000)

(FE-2434-33a; IR-2) Avail: NTIS HC A17/MF A01

Tests were conducted to acquire data with bituminous coal at high carbon conversions and to obtain data at high char conversions with high char throughputs. Tests were conducted to determine whether the major modifications recently incorporated would facilitate optimum operating conditions and clinkerfree operation. Tests were conducted to optimize reactor operation. by improving char conversion, increasing the temperature in the steam-oxygen gasifier to 1800 F, and continuing to reduce the steam-to-char ratios. Test were initiated to achieve a lower steam-to-char ratio and a significantly lower superficial gas velocity in the steam-oxygen gasifier. DOE

N80-31631# Rockwell International Corp. Canoga Park, Calif. Environmental and Energy Systems Div.

MOLTEN SALT COAL GASIFICATION PROCESS DEVELOP-MENT UNIT Quarterly Technical Progress Report, Jul - Sep. 1979

M. H. Slater 19 Oct. 1979 31 p (Contract EF-77-C-03-1429)

(SAN-1429-56; QTPR-14) Avail: NTIS HC A03/MF A01

The design construction, and operation of a process development unit (PDU) which will convert 1 ton of coal per hour into low-Btu gas is presented. Details were complete and all parts were fabricated for the melt withdrawal system modifications designed to increase the reliability of the system. The fabrication of pressure-rated gas burners for the melt withdrawal system was initiated. These heaters operate over the entire pressure range of PDU testing; i.e., from one atmosphere through 20 atmospheres.

N80-31633# Dravo Corp., Pittsburgh, Pa. Chemical Plant

PITTSBURGH ENERGY TECHNOLOGY CENTER HYDRO-GASIFICATION PROCESS: CONCEPTUAL COMMERCIAL SCALE PLANT DESIGN

28 Dec. 1979 115 p refs (Contract DE-AC21-78MC-08484)

(DOE/MC-08484/T1) Avail: NTIS HC A06/MF A01

Hydrogasification pilot plant tests at various H2:coal ratios and coal throughputs or North Dakota lignite, Illinois No. 6 and a Western sub-bituminous coal were reviewed. Additional testing at higher H2:coal ratios confirmed that greater coal throughputs were possible. Conceptual commercial scale plant designs based on the North Dakota lignité and the Illinois No. 6 coal showed total plant investment figures of \$1668 MM and \$1998 MM for the two coals, respectively. Gas costs based on the Unitity Finance Method of calculation yielded costs ranging from \$4.91/MM Btu and \$5.26/MM Btu for lignite at \$5.00 and \$8.00 per ton. Corresponding figures for the Illinois No. 6 coal were gas costs of \$6.08 to \$6.73 for coal costs of \$20 and \$30 per ton, respectively. Gas cost sensitivity analyses are performed. Further study of the process is warranted. DOE

N80-31634# Westinghouse Electric Corp., Madison, Pa. Advanced Coal Conversion Dept.

ADVANCED COAL GASIFICATION SYSTEM FOR ELECTRIC POWER GENERATION Quarterly Progress Report, 1 Jan. 31 Mar. 1979

31 Aug. 1979 68 p

(Contract EF-77-C-01-1514)

(FE-1514-101) Avail: NTIS HC A04/MF A01

Additional testing of the gasifier-agglomerator reactor included direct coal feed as well as oxygen-blown gasification of a char or coal bed. Support work on fuel processing was conducted to investigate operating conditions for the process development unit test program, provide troubleshooting capability for PDU operation, obtain data for PDU modifications, analyze and interpret results from PDU operation, develop process models for scale-up. and understand process phenomena to achieve reliable operation. Work was conducted in the areas of cold flow and analytical modeling, coal behavior, coal and ash chemical phenomena. environmental impact, and process and systems engineering consultation. DOE

N80-31635# Air Products and Chemicals, Inc., Allentown, Pa.
CRYOGENIC METHANE SEPARATION/CATALYTIC HY-DROGASIFICATION PROCESS ANALYSIS Quarterly Report, 15 Oct. 1978 - 15 Jan. 1979

16 Jan. 1979 19 p

(Contract ET-78-C-01-3044)

(FE-3044-T7) Avail: NTIS HC A02/MF A01

Efforts were directed towards identifying the most attractive acid gas removal systems, per case, based on preliminary screenings. Using proprietary information obtained from the respective vendors of the Benfield and Rectisol acid gas removal processes, preliminary cost estimates were complete for the Exxon CCG process. Several sets of computer simulations, for different acid gas removal configurations, for the Selexol process were developed to optimize methane recovery and utility

N80-31636# Institute of Gas Technology, Chicago, III. PIPELINE GAS FROM COAL: HYDROGENATION (IGT HYDROGASIFICATION PROCESS) Quarterly Report, 1 Oct. - 31 Dec. 1979

May 1980 75 p

(Contract EX-76-C-01-2434)

(FE-2434-58; QR-14) Avail: NTIS HC A04/MF A01

A data base to optimize the design of the HYGAS process Test 83 operations was established and post run inspection was conducted to determine the operating behavior of washed Kentucky coal under process conditions. After smooth, continuous solids transfer could not be established through the 339 line from the high temperature reactor to the steam/oxygen gasifier. the test was terminated. Several holes and a crack found in solids transfer line 339 during the post run inspection were the source of these difficulties. Test 84 was the second test of a new series with Western Kentucky coal, and the objectives were the same as those of Test 83. The reactor operated in a self sustained mode for 215 hours, during which 317 tons of pretreated char were fed to the gasifier. Three steady state periods totaling 83.5 hours, were selected for detailed analysis. Routine maintenance and major turnaround work in preparation for test 85 was started.

N80-31637# Institute of Gas Technology, Chicago, III. COAL GASIFICATION PILOT PLANT SUPPORT STUDIES Quarterly Report, 1 Apr. - 30 Jun. 1979

Jan. 1980 162 p refs (Contract ET-78-C-01-2806)

(FE-2806-5) Avail: NTIS HC A08/MF A01

Improving pilot plant operation, achieving expected conversion, and effecting cost savings are discussed. Projects are classified into four tasks as follows: (1) studies of gasification reactions for improving the performance of coal gasification reactors; (2) studies of fluidized bed reactors in coal gasification processes; (3) studies to improve the processing techniques of product and waste gase's from coal gasification; and (4) studies to improve methods of feed preparation for coal gasification. Each task is further divided into a number of subtasks dealing with specific aspects of the task. The objectives of the subtasks and their technical progress during the last quarter (April 1 through June 30, 1979) are presented. DOE

N80-31638# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

ADVANCED DEVELOPMENT OF A SHORT-RESIDENCE-TIME HYDROGASIFIER Annual Technical Progress Report 21 Jan. 1980 153 p refs

(Contract ET-78-C-01-3125)

(FE-3125-12) Avail: NTIS HC A08/MF A01

Relocation and modification of the subscale hydrogasifier test facility to accommodate longer duration testing was accomplished. A joint decision was made to scale the previously planned 1/4-TPH system to a nominal 3/4-TPH system. The required adjustments were primarily in the form of line size changes which were implemented during the installation of the process piping. Additional modifications to the reactor train support structure and handling capability were made to accommodate the larger reactor pressure vessel, having an 11.75 in. inside diameter. Facility modifications are planned to provide capability for simulated recycle gas feed, and provide for more representative sampling for improved material balances.

N80-31639# Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

ADVANCED DEVELOPMENT OF A SHORT-RESIDENCE-TIME HYDROGASIFIER Quarterly Technical Progress Report, 1 Jan. - 31 Mar. 1980

Apr. 1980 152 p refs

(Contract ET-78-C-01-3125)

(FE-3125-18) Avail: NTIS HC A08/MF A01

Progress in the development of test facilities for the hydrogasification of coal and peat is described. The surveillance of materials for components and carbon conversion efficiency are discussed. DOE

N80-31640# IIT Research Inst., Chicago, III. DESIGN, ENGINEERING AND EVALUATION OF RE-FRACTORY LINERS FOR SLAGGING GASIFIERS Quarterly Technical Progress Report, 1 Oct. - 31 Dec. 1979

R. F. Firestone, C. Hales, and M. J. Greaves Jan. 1980 27 p Prepared in cooperation with McKee (Davy) Corp., Cleveland (Contract ET-78-C-01-2785)

(IITRI-M-6043-5: QTPR-5) Avail: NTIS HC A03/MF A01

Temperatures in slagging gasifiers are in the 2500 T to 3300 F range which limits the materials which can be used. In addition the combination of high pressure (up to 1500 psi) with water vapor and the presence of carbon monoxide and hydrogen can present corrosion problems for refractories. Low iron, high alumina refractories are the presently preferred materials for coal gasification plants. The atmospheres and other conditions found in vessels used in coal gasification require the use of dense and insulating high Al2O3 refractory shapes and castables. Low SiO2 and low Fe2O3 refractories are necessary to resist steam and CO. In processes that involves molten carbonates or where slag may run down walls, fused cast Al2O3 is used to avoid corrosion and erosion. Considerable research is required to establish optimum refractory systems and design methods for slagging coal gasifiers.

N80-31641# Gulf Research and Development Co., Pittsburgh,

RESEARCH AND DEVELOPMENT OF AN ADVANCED PROCESS FOR CONVERSION OF COAL TO SYNTHETIC GASOLINE AND OTHER DISTILLATE MOTOR FUELS Final

D. C. Succop and F. E. Wynne Mar. 1980 98 p (Contract EX-76-C-01-1800)

(FE-1800-45) Avail: NTIS HC A05/MF A01 The conversion of coal to synthetic gasoline and other

distillate motor fuels, by delayed coking of a coal/petroleum resid slurry with an associated displacement of petroleum residual to the fluid catalytic cracking unit was studied. The cooking process met or exceeded technical and economic predictions. Ambient pressure coking experiments with two different coal slurries demonstrated synergistic increases in C3(+) distillate yield and product quality. Slurry viscosity measurements and heater fouling tests indicated only slightly pseudo-plastic slurry behavior and no unusual pumping resistance of pressure drop in slurry heaters. However, above 814 F rapid coking and heater fouling was experienced. Laboratory hydrogen transfer mechanism studies led to the conclusion that no C-C transfer occurred during coking. The process appears to be that of general H-H scrambling, perhaps promoted by the presence of a metal reactor and/or coal mineral matter functioning as a catalyst. DOE

N80-31642# North Dakota Univ., Grand Forks. Dept. of

CHEMISTRY OF LIGNITE LIQUEFACTION Quarterly Report, Jul. - Sep. 1978

Virgil I. Stenberg, Richard Baltisberger, Kenneth J. Kalbunde, Neil F. Woolsey, Donald Severson, and Max Souby Oct. 1978 82 p refs

(Contract EX-76-C-01-2211) (FE-2211-11) Avail: NTIS HC A05/MF A01

Various results related to the liquefaction of lignite are reported. The structural chemical analysis of oxygen and nitrogen compounds in coal liquids is facilitated by acetylation. Solvent refined lignite and solvent refined coal were hydrogenated using a variety of catalysts. The resulting liquids were fractionated by distillation and examined by mass spectroscopy and nuclear magnetic resonance. Model compounds were reduced using carbon monoxide-water or hydrogen using various catalysts (among others fly ash) in an effort aimed at reducing the severity of coal liquefaction conditions: Electron transfer from thermally activated magnesium oxide powder to nitrobenzene and adsorbed carbon monoxide was also studied.

N80-31644# Engineering Societies Commission on Energy, Inc., Washington, D. C.

MATERIALS FOR COAL CONVERSION AND USE. **VOLUME 2: MATERIALS OF CONSTRUCTION FOR COAL** CONVERSION SYSTEMS. PART 1: COAL GASIFICATION. PART 2: COAL LIQUEFACTION Final Report

Vinod K. Nangia Oct. 1979 409 p refs (Contract EF-77-C-01-2468)

(FE-2468-59-Vol-2-Pt-1/2) Avail: NTIS HC A18/MF A01

The principles of coal gasification and liquefaction are reviewed and the various technologies and equipment used are examined. Present and past work on the behavior of materials in coal conversion and use environments is reported. Available data are evaluated and problems areas related to materials are identified. Operating conditions are defined for these technologies in terms of temperature, pressure, erosive and corrosive environments, and their effects on the construction materials. Candidate materials are proposed based on extrapolation of the available data and related experience from other technologies. Areas needing further research and development are recommeneded.

N80-31645# TRW Energy: Systems Planning Div., McLean, Va. METHANE RECOVERY FROM COALBEDS PROJECT, PHASE 2 Annual Report, 1979

1979 101 p

(Contract DE-AC21-78MC-08089)

(DOE/MC-08089/T4) Avail: NTIS . HC A06/MF A01

Field activities relating the estimation of the methane resources contained in the nation's coalbeds and the determination of exploration and production technologies that allow extrapolation from test sites to larger resource areas are reported. Projects goals and management are also addressed.

N80-31646# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

LIQUID FUELS FROM BIOMASS: CATALYSTS AND REACTION CONDITIONS

Manu Seth, Sabri Ergun, Ted Vermeulen, and Roger Djafar Apr. 1980 72 p refs

(Contract W-7405-eng-48)

(LBL-9789) Avail: NTIS HC A04/MF A01

The use of alpha-phellandrene as a hydrogen transfer agent in wood liquefaction was studied at 200 C. No significant thermally promoted hydrogen transfer occurred under these conditions. Dilute sulfuric acid was added to test the possibility of hydride transfer from alpha-phellandrene to wood. Extensive solvent alkylation of the wood occurred in the presence of up to 2 wt % of sulfuric acid. Addition of palladium as a hydrogenation catalyst resulted in lower overall conversion based on the toluene-insoluble residue obtained, and in lowered levels of solvent alkylation. Several inorganic salts were tested as catalytic additives for wood liquefaction at 250 C in the presence of tetralin as a possible hydrogen donor. No hydrogen transfer from the solvent was observed. Of the additives tested, nickel chloride, sodium carbonate, and ferric chloride resulted in wood conversions greater than or equal to those obtained in the absence of an additive.

N80-31647# Battelle Columbus Labs., Ohio. ECONOMIC EVALUATION OF THE MIT PROCESS FOR MANUFACTURE OF ETHANOL

D. M. Jenkins and T. S. Reddy 28 Jun. 1979 32 p refs (Contract ET-78-X-01-3992)

(DSE-3992-T1) Avail: NTIS HC A03/MF A01

Conceptual process designs were developed for two cases, Case A which was based on the experimental data obtained to date, and Case B which hypothesized the suppression of acid byproducts. Economic estimates may be slightly on the low side since they did not consider feedstock storage nor working capital requirements. The manufacturing costs for Case A appeared to be comparable to those of the manufacture of ethanol from corn. The plant size used for this analysis was 1500 ton/day corn stover. This is considered to be a realistic size. The conceptual plants make about 27 million gal/yr ethanol in Case A and 41 million gal/yr in Case B. DOE

N80-31648# Midwest Research Inst., Golden, Colo. Energy Research Inst.

SURVEY OF BIOMASS GASIFICATION. VOLUME, 3: CURRENT TECHNOLOGY AND RESEARCH

Apr. 1980 302 p refs 3 Vol. (Contract EG-77-C-01-4042)

(SERI/TR-33-239-Vol-3) Avail: NTIS HC A14/MF A01

This survey of biomass gasification was written to areas of gasification that are ready for commercialization now and those areas in which further research and development will be most productive. Consideration is given to: a survey of gasifier types; a directory of current manufacturers of gasifiers and gasifier development programs; and a sampling of gasification research and development programs and their unique features. Air gasification for the conversion of existing gas/oil boiler systems to biomass feedstocks is compared with the price of installing new biomass combustion equipment. Chapter 12 treats gas conditioning as a necessary adjunct to all but close-coupled gasifiers, in which the product is promptly burned. Synthesis gas processes for conversion to methanol, ammonia, gasoline, or methane are evaluated technically and economically.

N80-31653# Gulf Research and Development Co., Pittsburgh, Pa. Chemical and Minerals Div.

UNDERGROUND GASIFICATION FOR STEEPLY DIPPING COAL BEDS. RAWLINS TEST NO. 1

1980 29 p Prepared in cooperation with TRW Energy Systems Planning Div., McLean, Va.

(SAN-13108-35; Rept-624RL106) NTIS Avail:

HC A03/MF A01

The first US field test of gasification for a steeply dipping coal seam was recently completed. A 23 ft thick coal bed dipping at 63 was used to test the feasibility of using underground coal gasification techniques to extract energy from steeply dipping coal beds. The coal was ignited at a vertical depth of 400 ft utilizing a directionally drilled process well pair. The test was designed to investigate the effects of water/air injection, steam/air injection, and steam/oxygen injection. According to plan approximately 1200 tons of coal were utilized during the test. The heating value of the product gas initially climbed to approximately 180 Btu/SCF and as expected, gradually declined to the 120 to 130 Btu/SCF range. A five day steam/oxygen blown experiment was conducted subsequent to the steam/air phase. As expected steam/oxygen injection easily doubled the product gas heating value to the 240 to 260 Btu/SCF range. DOE

N80-31654# California Univ., Livermore. Lawrence Livermore

LLL IN SITU COAL GASIFICATION PROJECT Quarterly Progress Report, Oct. - Dec. 1979

Robert J. Cena, ed. and Barbara S. Strack, ed. 23 Apr. 1980 40 p refs Sponsored in part by Gas Research Inst. (Contract W-7405-eng-48)

(UCRL-50026-79-4) Avail: NTIS HC A03/MF A01

Thermal data were analyzed to determine the performance of the drilled horizontal channel during forward gasification. Thermal and material balance data were combined to determine

late time burn boundaries for the experiment. Process wells were inspected to determine failure characteristics and pinpoint late-time injection location. Ground water quality before and after Hoe Creek No. 3 and the effects of aquifer interconnection on hydraulic measurements at the Hoe Creek No. 2 and No. 3 sites are discussed DOE

N80-31655# Sandia Labs., Albuquerque, N. Mex. Thermal Processes Div.

INSTRUMENTATION AND PROCESS CONTROL DEVELOP-MENT FOR IN SITU COAL GASIFICATION Quarterly Report, 1 Dec. 1979 - 31 Mar. 1980

Robert E. Glass, ed. Jun. 1980 26 p refs

(Contract DE-AC04-76DP-00789)

(SAND-80-1025) Avail: NTIS HC A03/MF A01

The Hanna 4B thermal data was analyzed with respect to the fundamental controlling mechanisms in in situ coal gasification. Two of the concerns center on: (1) the behavior of the reservoir with respect to varying permeability zones and (2) mechanisms of initial cavity growth during forward gasification. In an attempt to deal with these concerns, two specific areas of interest are being pursued: (1) a reservoir model with variable permeability; and (2) a structural model of the coal seam using the finite element program ADINA. While these models remain in the development stage, initial results indicate that the approaches being used will yield useful results when completed.

N80-31656# Brigham Young Univ., Provo, Utah. Dept. of Chemical Engineering.

MIXING AND GASIFICATION OF COAL IN ENTRAINED FLOW SYSTEMS. VOLUME 2: USER'S MANUAL FOR A COMPUTER PROGRAM FOR 1-DIMENSIONAL COAL COMBUSTION OR GASIFICATION (1-DICOG) Final Report

L. Douglas Smoot and Philip J. Smith 31 Aug. 1979 215 p refs Sponsored in part by Electric Power Research Inst. (Contract EF-77-S-01-2666)

(FE-2666-F-Vol-2) Avail: NTIS HC A10/MF A01

A one dimensional, steady state model describing pulverized coal combustion and gasification is presented. Emphasis was placed on the description of the coal reaction processes and gas particle interactions, one dimensional fluid mechanics and particle-particle, particle-wall radiation. Moisture vaporization from the coal particles, multistep coal pyrolysis, and heterogeneous char oxidation by multiple oxidizers were modeled for polydispersed coal particle size or types. Although the formation was one dimensional, mixing rates of primary and secondary streams and recirculation within the reactor were accounted for as specified input. The resulting model predicted thermal, chemical and physical histories for both the gaseous and particle phases. Gas-particle interactions accounted for appropriate diffusion and kinetic rates. Gas phase reactions were assumed to be in local chemical equilibrium. The solution technique used predictorcorrector methods for integration of the ordinary nonlinear differential equations which were coupled with a number of DOE auxiliary algebraic equations.

N80-31658# Department of Energy, Pittsburgh, Pa. Energy Technology Center.

RECENT COAL-OIL MIXTURE COMBUSTION TESTS AT **PETC** 

Y. S. Pan, G. T. Bellas, M. P. Mathur, J. I. Joubert, and D. Bienstock Jun. 1980 38 p refs (DOE/PETC-TR-80/5) Avail: NTIS HC A03/MF A01

Coal-oil mixture combustion tests with coal concentration of up to 50 percent were successfully conducted in a 700 horsepower watertube boiler designed originally for oil firing. A 500 h duration test with coal-oil mixture containing 40 percent coal was completed. No derating of the boiler occurred. carbon-conversion efficiencies were above 98 percent, and boiler efficiencies were the same as when firing No. 6 fuel oil. All combustion tests were conducted with No. 6 fuel oil mixed with Pittsburgh Seam coal pulverized to a coal particle size of 90 percent minus 200 mesh. Test results relating to boiler performance, pollutant emissions, ash deposition, and corrosion, erosion, and fouling behavior are presented.

N80-31659# Institute of Gas Technology, Chicago, III. DEVELOPMENT OF COMBUSTION DATA TO UTILIZE LOW-Btu GASES AS INDUSTRIAL PROCESS FUELS: MODIFICATION OF FLAME CHARACTERISTICS Quarterly Report, 1 Jan. - 31 Mar. 1980

Richard T. Waibel Apr. 1980 7 p (Contract DE-AC01-79ET-14851)

(DOE/ET-14851/2) Avail: NTIS HC A02/MF A01

The burner modifications that yield suitable flame characteristics and shapes with oxygen blown gases manufactured from coal were determined. Methods of enchancing the flame characteristics of manufactured gases from air-blown gasifiers were evaluated.

N80-31660# National Technical Information Service, Springfield.

SYNTHETIC FUELS FROM MUNICIPAL, INDUSTRIAL, AND AGRICULTURAL WASTES. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Jun. 1980

Audrey S. Hundemann Jun. 1980 230 p Supersedes NTIS/PS-79/0545: NTIS/PS-78/0499

(PB80-811375; NTIS/PS-79/0545; NTIS/PS-78/0499) Avail:

NTIS HC \$30.00/MF \$30.00 CSCL 21D

Research efforts directed toward production of gaseous and liquid synthetic fuels from solid wastes are discussed. Waste products used in the syntheses include manure, sewage, paper, and wood. In most citations, methane is the primary fuel produced: however, the production of oils, methanol, and ethanol is also discussed. This updated bibliography contains 218 abstracts, 54 of which are new entries to the previous edition.

N80-31900# Colorado State Univ., Fort Collins. Dept. of Civil Engineering.

SITES FOR WIND-POWER INSTALLATIONS: PHYSICAL MODELING OF THE INFLUENCE OF HILLS, RIDGES AND COMPLEX TERRAIN ON WIND SPEED AND TURBULENCE. PART 1: EXECUTIVE SUMMARY

R. N. Meroney, V. A. Sandborn, R. J. B. Bouwmeester, H. C. Chien, and M. Rider Jun. 1978 102 p refs (Contract EY-77-S-06-2438)

(RLO-2438-78/1) Avail: NTIS HC A06/MF A01

Wind tunnel model measurements were performed to study the influence of topography profile, surface roughness and stratification on the suitability of various combinations of these variables for wind power sites. For the range of examined cases (large turbulence integral scales with respect to surface feature scales) the flow is dominated by inviscid dynamics. Detailed tables of velocity, turbulence intensity, pressure, spectra, etc., were prepared to guide numerical model design and experimental rule of thumb constrictions. Cases include hill slopes, neutral and stratified flows, two and three dimensional symmetric ridges, six alternate hill and escarpment shapes, and a variety of windward versus leeward slope combinations to evaluate ridge separation characteristics. DOE

N80-31901# Colorado State Univ., Fort Collins. : Dept. of Civil Engineering.

SITES FOR WIND POWER INSTALLATIONS: WIND CHARACTERISTICS OVER RIDGES, PART 2 Final Report R. J. B. Bouwmeester, R. N. Meroney, and V. A. Sandborn Jun. 1978 122 p refs

(Contract EY-77-S-06-2438)

(RLO-2438-78/2) Avail: NTIS HC A06/MF A01

A wind tunnel study of the flow field over triangular shaped and sinusoidal shaped ridge models with varying upwind and downwind slopes under various thermal stratification conditions was conducted. A simple technique was developed to predict the velocity amplification profile above a ridge crest for an arbitrary ridge slope. Largest speedups were measured for the steepest symmetrical ridge which did not cause flow separation. Criteria for flow separation over ridges are provided in this report. Applicability of the results for ridges with finite width is discussed. DOF

N80-31902# Oak Ridge National Lab., Tenn. FOSSIL ENERGY PROGRAM Quarterly Progress Report, period ending 31 Dec. 1979 Apr. 1980 336 p

(Contract W-7405-eng-26)

(ORNL-5630) Avail: NTIS HC A15/MF A01

Research and development projects that were carried out in support of the increased utilization of coal are described. Other fossil fuel alternatives to oil and gas as sources of clean energy

N80-31912# Physical Sciences, Inc., Woburn, Mass. COAL PROCESSING FOR FUEL CELL UTILIZATION: TASK 9: ONE-DIMENSIONAL (STREAMTUBE) MODEL FOR ENTRAINED-FLOW GASIFIER ANALYSIS

P. F. Lewis and M. L. Finson Oct. 1979 72 p refs

(Contract EW-78-A-21-8450) (METC-8450-T2-Vol-1; TR-198A)

HC A04/MF A01

NTIS

A model was developed to describe the phenomena which occur in entrained flow gasifiers similar to the METC G3 approximation, and includes finite rate pyrolysis and homogeneous and heterogeneous chemistry. The model also includes radiative and conductive heat transfer, and has the capability of including a distribution of particle sizes. The results indicate that finite rate gas phase chemistry and the presence of smaller particles play a significant role in determining the location of the flame within the gasifier.

N80-31946# Department of Energy, Washington, D. C. Assistant Secretary for Conservation and Solar Energy.

OCEAN ENERGY SYSTEMS: MULTIYEAR PROGRAM PLAN

May 1980 130 p

(DOE/CS-0161) Avail: NTIS HC A07/MF A01

Specific planned activities to be conducted by the Department of Energy in connection with the Ocean Energy System Program for FY 1979 through FY 1984 are described. Program funding is presently 95 percent OTEC, with 5 percent directed toward alternate energy sources such as salinity gradients waves and currents, technical status, ocean energy systems resource requirements, issues, and a management plan are discussed.

DOE

N80-31986# Research Triangle Inst., Research Triangle Park, N. C.

POLLUTANTS FROM SYNTHETIC FUELS PRODUCTION: COAL GASIFICATION SCREENING TEST RESULTS

J. G. Cleland, S. K. Gangwal, C. M. Sparacino, R. M. Zweidinger, D. G. Nichols, and F. O. Mixon Aug. 1979 101 p refs (Grant EPA-R-804979)

(PB80-182769: EPA-600/7-79-200)

HC A06/MF A01 CSCL 13B

Coal gasification test runs were conducted in a semibatch, fixed bed laboratory gasifier in order to evaluate various coals and operating conditions for pollutant generation. Extensive analyses were performed for organic and inorganic compounds and trace elements in the tars and hydrocarbon oils, aqueous condensates, and reactor residues resulting from the gasification tests. Results are reported for sulfur species in the product gas stream, for consent decree pollutants contained as volatile organic compounds in the product gas, for phenol and related compounds in the aqueous condensate and tar/oil sample, and for polynuclear aromatic hydrocarbons species in the tar/oil.

N80-31990# North Carolina State Univ., Raleigh. Chemical Engineering.

COAL GASIFICATION/GAS CLEANUP TEST FACILITY: **VOLUME 1. DESCRIPTION AND OPERATION Final Report.** Sep. 1977 - Dec. 1978

J. K. Ferrell, R. M. Felder, R. W. Rousseau, J. C. McCue, R. M. Kelly, and W. E. Willis Mar. 1980 108 p refs

(Grant EPA-R-804811) (PB80-188378; EPA-600/7-80-046A-Vol-1) Avail: NTIS HC A06/MF A01 CSCL 13B

An integrated fluidized-bed coal gasification reactor and acid gas removal system are described. The gasifier operates at 100 psig at up to 2000 F, and has a coal feed capacity of 50 lb/hr. The gas cleaning system contains a cyclone, a venturi scrubber, and an absorber/flash/tank/stripper system for acid gas removal. A detailed description of the plant and associated facilities, a summary of operating procedures, and results of a run for the steam oxygen gasification of a Western Kentucky No. 11 coal char are given. By following the outlined operating procedures, the plant can be brought to steady state in less than 4 hours.

N80-32272# Skelly and Loy, Harrisburg, Pa. GENERAL APPLICATION OF THE CRITICAL PATH METHOD TO RESOURCE CHARACTERIZATION AND PLANNING FOR UNDERGROUND COAL MINING Final Technical Report May 1980 287 p refs

(Contract DE-ACO1-79ET-11268)

(DOE/ET-11268/3) Avail: NTIS HC A13/MF A01

Application of the critical path method (CPM) to the total mine planning process is described. A commercially available CPM software package called SPRED (Solution of the Precedence Diagram) was chosen. A key prerequisite to the application of CPM was the identification of all of the activities involved in the mine planning process and the determination of all of the interrelationships that exist between them. A network format depicted all of the activities as labeled boxes in their proper logical sequence of events. Interdependencies were shown by lines connecting the related activities. Information necessary for the application of critical path scheduling techniques was produced and the data prepared in the format suitable for input to the SPRED system.

N80-32278# Oak Ridge Gaseous Diffusion Plant, Tenn. Computer Sciences Div.

REVIEW OF DEPARTMENT OF ENERGY SPONSORED CODES AND DOCUMENTATION AVAILABLE FROM PURDUE AND LEHIGH UNIVERSITIES PROCESSES MODELING CONTRACTS

David M. Lister Apr. 1980 43 p refs (Contract W-7405-eng-26)

(K/CSD/TM-35) Avail: NTIS HC A03/MF A01 '

The Purdue project had two principal objectives. The first was to construct a modular computer simulation package for the design of coal conversion systems. The second was to use this package to study general coal conversion flowsheet alternatives.' Seven general codes and seven models of major components of the modified Illinois Coal Gasification Group (ICGG) process were developed. The object of the Lehigh work was to select, assemble and develop numerical algorithms implemented as computer codes for the dynamic analysis and continuous simulation of the modified ICGG coal conversion plant. Two general-purpose programs and nine models of major components of the ICGG plant were developed. A brief description of these programs and their availability and performance on the Oak Ridge IBM computer systems are presented.

N80-32467# Argonne National Lab., III. Energy and Environmental Systems Div.

PULSE COMBUSTION TECHNOLOGY FOR HEATING APPLICATIONS Quarterly Progress Report, 1 Jan. - 31 Mar. 1980

C. A. Blomquist, J. M. Clinch, and F. W. Ahrens Apr. 1980 28 p refs

(Contract W-31-109-eng-38)

(ANL/EES/TM-85) Avail: NTIS HC A03/MF A01

The technology base for fossil fuel fired pulse combustion heating systems was developed. Design data and design procedures for pulse combustion burners were developed. This design capability contributes to the accelerated industrial development of cost effective, high efficiency systems for a variety of heating applications. DOE

N80-32472# Lehigh Univ., Bethlehem, Pa. Center for Surface and Coatings Research.

METHANOL AND METHYL FUEL CATALYST Progress Report, Sep. 1978 - Nov. 1979

Kamil Klier and Richard G. Herman Dec. 1979 9 p refs (Contracts DE-ASO1-78ET-10741; ET-78-S-01-3177) (FE-3177-5) Avail: NTIS HC AO2/MF AO1

Results of diffuse reflectance studies and quantitative X-ray powder diffraction measurements supported the proposal that Cu(+)/ZnO solid solution is the catalytically important moiety in low pressure methanol synthesis catalysts. A decrease in CO2 concentration led to a decrease in carbon conversion to methanol over Ak based Cu/ZnO catalysts. This difference in kinetic behavior showed a remarkable influence of the support on the course of the synthesis. The dependence of reaction rates on CO2 concentration was actively investigated for these catalysts and for La based ternary catalysts, as well as for binary and ternary catalysts doped with alkali metal ions such as Rb(+). Although the effects on the methanol synthesis kinetics in the presence of CO2 were very marked, oxides did not appear to change the composition of the product and all catalysts investigated here are still highly selective to methanol. DOE .

N80-32473# Johns Hopkins Univ., Baltimore, Md. Chemical Engineering Dept.

CONDENSATION PROCESSES IN COAL COMBUSTION PRODUCTS Progress Report, 1 Jul. 1979 - 30 Jun. 1980 Joseph L. Katz and Marc D. Donohue Apr. 1980 12 p ref (Contract DE-AS02-79ER-10456; ER-78-S-02-4947) (DOE/ER-10456/1) Avail: NTIS HC A02/MF A01

Slag vaporization is a serious problem in high temperature coal combustion and gasification processes. Cooling of process gas streams causes the slag vapors to condense, but they do not necessarily do so at equilibrium. Predicting the compositions and properties of the condensing species requires modeling the nucleation processes occurring in these systems. Progress toward modeling this nucleation process and toward implementing the model with a computer code suitable for design calculations is reported.

N80-32533\*# Lockheed-California Co., Burbank.
STUDY OF METHANE FUEL FOR SUBSONIC TRANSPORT
AIRCRAFT Final Report, Jan. 1978 - Aug. 1979

L. K. Carson, G. W. Davis, E. F. Versaw, George R. Cunnington, Jr., and E. J. Daniels Sep. 1980 371 p refs (Contract NAS1-15239)

(NASA-CR-159320; LR-29157) Avail: NTIS HC A16/MF A01 CSCL 21D

The cost and performance were defined for commercial transport using liquid methane including its fuel system and the ground facility complex required for the processing and storage of methane. A cost and performance comparison was made with Jet A and hydrogen powered aircraft of the same payload and range capability. Extensive design work was done on cryogenic fuel tanks, insulation systems as well as the fuel system itself. Three candidate fuel tank locations were evaluated, i.e., fuselage tanks, wing tanks or external pylon tanks. R.C.T.

N80-32545# Dynatech Corp., Cambridge, Mass.
LIQUID FUELS PRODUCTION FROM BIOMASS Progress
Report, 1 Oct. - 31 Dec. 1979

J. E. Sanderson, P. F. Levy, D. L. Wise, M. R. Nabor, M. S. Molyneaux, and C. A. Hughes 1 Feb. 1980 67 p refs (Contract DE-AC02-77ET-20050)

(COO-4388-10; Rept-1987; PR-10) Avail: NTIS HC A04/MF A01

It was found that marine algae could be converted to higher aliphatic organic acids and that these acids could be readily removed from the fermentation broth by membrane or liquid-liquid extraction. It was then proposed to convert these higher organic acids via Kolbe Electrolysis to aliphatic hydrocarbons, which may be used as a diesel fuel. A coenzyme M analogue, 2-bromoethane-sulfonic acid was shown to be an effective suppressor of methane in nonsterile anaerobic fermentation of cellulosic substrates. Preliminary experiments were completed utilizing corn meal in

which 2-bromoethanesulfonic acid and carbon monoxide were both found to be effective methane suppressors. The energy outputs and requirements for the production of liquid hydrocarbon fuel from corn are analyzed. As a means of expanding the number of potential substrates, pretreatment schemes are being investigated.

N80-32547# Argonne National Lab., III. Energy and Environmental Systems Div.

## tal Systems Div. ASSESSMENT OF PERUVIAN BIOFUEL RESOURCES AND ALTERNATIVES

Jerome P. Harper, Wayne Smith (Florida Univ., Gainesville), and Eliseo Mariani (Marelco, Inc.) Aug. 1979 57 p refs (Contract W-31-109-eng-38)

Appraisal of the biofuel potential of Peru was based on:

determination of current biofuel productivity; identification of

Peruvian agricultural and forestry resources; assessment of

resource development and management concerns; identification

(ANL/EES/TM-86) Avail: NTIS HC A04/MF A01

of market considerations; description of biofuel technological options; and identification of regional biofuel technology applications. Nine biofuel technology options for Peru are identified: (1) small to medium scale gasification: (2) a wood waste inventory: (3) stationary and mobile charcoal production systems; (4) wood distillation; (5) forest resource development and management; (6) electrical cogeneration; (7) anaerobic digestion technology; (8) development of ethanol production capabilities; and (9) agricultural strategies for fuel production. Applications of these biofuel options are identified for each of the three major regions

N80-32548# Department of Energy, Washington, D. C. Assistant-Secretary for Conservation and Solar Energy.

DOE

## FIRST REPORT TO CONGRESS ON THE USE OF ALCOHOL IN MOTOR FUELS Annual Report

1 Apr. 1980 62 p (DOE/CS-0165; AR-1) Avail: NTIS HC A04/MF A01

of the country.

The following information is presented: (1) a description of the firms engaged in the alcohol fuel industry; (2) the amount of alcohol fuels sold in each state and the amount of gasoline saved in each state by reason of the use of alcohol fuels; (3) the revenue loss resulting from the exemptions from tax for alcohol fuels; and (4) the cost of production and the retail cost of alcohol fuels as compared to gasoline and special fuels before the imposition of any Federal excise tax. During 1979, a rapid increase in marketing of alcohol fuel, specifically the 10% blend known as gasohol, has caused a significant gap between the motor fuel marketplace and the information system(s) that compile a consistent data base for domestic energy production and consumption.

N80-32552# Michigan Univ., Ann Arbor. Dept. of Mechanical Engineering.

MÖDIFICÄTIONS FOR USE OF METHANOL OR METHA-NOL-GASOLINE BLENDS IN AUTOMOTIVE VEHICLES Technical Report, Sep. 1970 - Jan. 1980

D. J. Patterson, J. A. Bolt, and D. E. Cole Jan. 1980 194 p. refs

(Contract DE-AC04-76CS-53682)

(ALO-3682-T1) Avail: NTIS HC A09/MF A01

Potential problems in the use of methanol or blends of methanol and gasoline as automotive fuels are examined. Retrofitting of existing vehicles as well as future vehicle design is considered. Several potentially serious problems are identified with methanol use. The most attractive solutions depend upon an integrated combination of vehicle modifications and fuel design. No vehicle problems are found which could not be solved with relatively minor developments of existing technology providing the methanol or blend fuel was itself engineered to ameliorate the solution. Research needs are identified in the areas of lubrication and materials. Because of the substantial costs and complexities of a retrofitting program, use of methanol must be evaluated in relation to other petroleum saving alternatives. Future vehicles can be designed initially to operate satisfactorily on these alternate fuels. However a specific fuel composition must

be specified around which the future engines and vehicles can be designed.

N80-32555# Department of Energy, Washington, D. C. Div. of Coal Conversion.

COAL DEMONSTRATION PLANTS Quarterly Report, Apr. -Jun. 1979

Apr. 1980 75 p

(DOE/FE-0004/79-2) Avail: NTIS HC A04/MF A01

Second generation technologies were demonstrated. The economic, environmental and productive capacity of a near commercial-size plant were validated by integrating and operating a modular unit using commercial size equipment. These facilities were aimed at accelerating and reducing the risks of industrial process implementation. Contracts for the design, construction, and operation of the demonstration plants were awarded through competitive procedures and were cost shared with the industrial partner. The government share of the cost involved for a demonstration plant depends on the plant size, location, and the desirability and risk of the process to be demonstrated. The various plants and programs are discussed: description and status, funding, history, flowsheet and progress during the current quarter.

N80-32556# Worcester Polytechnic Inst., Mass.

KINETICS AND MECHANISMS OF CATALYTIC HYDROLI-QUEFACTION AND HYDROGASIFICATION OF LIGNITE Quarterly Report, Jan. - Mar. 1980

Alvin H. Weiss, Wilmer L. Kranich, and Kemal Gueruez 20 Apr. 1980 29 p

(Contracts DE-AS01-77ET-10618)

(FE-2702-10) Avail: NTIS HC A03/MF A01

Delay in the delivery of a new pump prevented expansion of the range of flow rates already studied on lignite liquefaction in the continuous stirred tank reactor. Data previously reported have been refined and for the most part confirmed. Agitator speed does not affect reaction rate over the range of speeds used in experimental runs, but hydrogen pressure appears to exert an influence particularly at higher temperatures. A new batch reactor was put into operation which is expected to yield valuable catalyst screening and kinetic data. Successful design, fabrication, and operation of a fast-feed mechanism should greatly reduce the long preheating times which obscure the kinetic results of most batch studies.

N80-32557# Westinghouse Electric Corp., Madison, Pa. Advanced Coal Conversion Dept.

ADVANCED COAL GASIFICATION SYSTEM FOR ELECTRIC POWER GENERATION Quarterly Progress Report, 1 Oct. --31 Dec. 1979

L. A. Salvador 25 Jan. 1980 74 p (Contracts DE-AC01-76ET-10161; EF-77-C-01-1514)

(FE-1514-113; QPR-1) Avail: NTIS HC A04/MF A01

The results of gasification process development tests are reported. A review of the data and the effect of various modifications on cyclone deposits was conducted. It is tentatively concluded that the mechanism of deposit formation is the result of sticky particles or liquid droplets out of the combustion and/or gasification zone impacting on the hot refractory cyclone walls as a result of change in direction of flow. A water spray nozzle was installed in the freeboard area of the gasifier to quench particles with a liquid film and render them nonsticky. Water spray was also used to cool the gas and particles from 1800 F to 1300 F. At this temperature, the deposit was practically eliminated. However, long-duration tests with Pittsburgh seam and Ohio No. 9 coals are necessary before any firm conclusions can be drawn about the effect of water spray. Significant progress was made in the construction of the cold-flow, scale-up facility. In addition, studies were made on the reactivity of various chars in the laboratory fluidized bed.

N80-32560# Sandia Labs., Albuquerque, N. Mex. CATALYST CHARACTERIZATION IN COAL LIQUEFACTION Annual Report, 1 Oct. 1978 - 30 Sep. 1979

M. G. Thomas and D. G. Sample Jun. 1980 57 p refs (Contract DE-AC04-76DP-00789) (SAND-80-0123) Avail: NTIS HC A04/MF A01

Neutron activation of American Cyanamid 1442A CoMo catalyst was employed to tag a one day's charge of catalyst in H-Coal PDU run no. 9. The activity of Co-60 in the withdrawals has shown that 8 days are required to uniformly distribute a daily addition of catalyst in the bed during PDU run no. 9. Catalysts used in the LC-Fining of SRC-1 show aging characteristics similar to H-Coal catalyst: 20 to 30 w/o organic contamination, 2 to 5 w/o inorganic contamination, 50 percent loss of surface area, and changes in pore volume distributions. Elemental distribution of contaminants indicate that the catalysts are extremely efficient metals scavengers, with titanium and iron major contaminants penetrating 200 micrometers into the catalysts. A mechanistic pathway for coal liquefaction were experimentally verified by the combination of low temperature (25 to 300 C) batch reaction data in inert atmospheres, high temperature-moderate pressure reaction data (500 psi H2) from tubing reactors at 400 and 426 C, and high pressure (2000 psi H2) data collected in a continuous reactor at 400, 425, and 450 C.

N80-32562# Los Alai ios Scientific Lab., N. Mex. MICRO-LEVEL LAND USE IMPACTS OF BIOCONVERSION Virginia Parsons 1980 6 p refs Presented at IASTED Energy Symp., Montreal, 28 May 1980 (Contract W-7405-eng-26)

(LA-UR-80-1426; CONF-800567-2) Avail: NTIS HC A02/MF A01 Local biomass potential, existing and use and potential land use impacts from bio-energy implementation for three of the fifteen counties selected for the TASE study are presented. The methodology created for the evaluation is useful in determining the biomass potential for any community or county, and in identifying regional differences inherent in the tradeoffs between existing land use and energy production.

N80-32564# California Univ., Berkeley. Lawrence Berkeley Lab. Energy and Environment Div.

CALIFORNIA'S BIOMASS AND ITS ENERGY POTENTIAL

Ph.D. Thesis

Frank Bart Lucarelli, Jr.: Apr. 1980 317 p refs (Contract W-7405-eng-48)

(LBL-10058) Avail: NTIS HC A14/MF A01

Estimates of the costs of transforming biomass into different fuels as well as a survey of government's role in a biomass energy program are presented. The major findings are summarized below. (1) California's existing biomass resources are sufficient to provide only 20 percent of its future liquid fuel requirements. (2) Meeting the full transportation demand with biomass derived fuels will require the development of exotic biomass sources such as kelp farms and significant reduction in automobile travel in the State. (3) Under assumptions of moderate increases in gasoline prices and without major new government incentives, the cost of transforming biomass into transport fuels will be competitive with the price of gasoline on a Btu basis by the year 1990. (4) The environmental impacts of collecting most forms of biomass are beneficial and should reduce air pollution from agricultural burning and water pollution from feedlot and dairy farm runoff.

N80-32565# California Univ., Livermore. Lawrence Livermore

USE OF AN AUTOMATED MASS SPECTROMETER FOR AN UNDERGROUND COAL GASIFICATION FIELD TEST R. W. Crawford, R. G. Bedford, C. M. Wong, H. R. Brand, and K. I. Kishiyama Jul. 1980 29 p refs Presented at the Intern. Dyn. Mass Spectometry Symp., Canterbury, England, 7-10 Jul. 1980

(Contract W-7405-eng-48)

CONF-800732-1) (UCRL-84366; HC A03/MF A01

Avail:

A time-of-flight mass spectrometer was used to analyze the product gas from an underground coal gasification field experiment. It proved to be precise and moderately accurate. It was extremely stable and reliable. Its speed was more than adequate for most

requirements. The analysis of product gas was fully automated, but any other operation took manual intervention DOE

N80-32566# California Univ., Livermore. Lawrence Livermore Lab.

## ECONOMICS OF SHALE OIL PRODUCTION BY RADIO FREQUENCY HEATING

Richard G. Mallon 7 May 1980 11 p refs

(Contract W-7405-eng-48)

(UCRL-52942) Avail: NTIS HC A02/MF A01

A conceptual facility for the production of shale oil by radio frequency (rf) heating was designed to evaluate the economic feasibility of this technique. The shale was processed in situ without being rubbed or explosively fractured. Metal electrodes inserted in a set of vertical drill holes were energized by a group of rf oscillators. The electric field was developed in such a way that heating within the block was almost uniform, and heating outside the block was very low. The facility schedule is planned so that off-peak electric power from existing generating stations is used to operate the oscillators. The two principal costs are purchase of electric power and mining operations. The largest capital requirement is oscillators and associated electrical equipment.

N80-32567# Institute of Gas Technology, Chicago, III.
SYNTHETIC FUELS FROM US OIL SHALES: A TECHNICAL
AND ECONOMIC VERIFICATION OF THE HYTORT PROCESS Quarterly Report, 1 Jan. - 31 Mar. 1980

Jun. 1980 71 p ref

(Contract DE-AC01-79ET-14102)

(DOE/ET-14102-2) Avail: NTIS HC A04/MF A01

The technical and economic feasibility of the HYTORT process for both Eocene and Devonian shales was demonstrated. The program is divided into five major task areas: laboratory program: vench scale program: process development unit tests: process environmental assessment; and process design and economics.

DOE

N80-32568# Gulf Research and Development Co., Pittsburgh,

INVESTIGATION OF MECHANISMS OF HYDROGEN TRANSFER IN COAL HYDROGENATION, PHASE 2 Annual Report, Jan. - Dec. 1978

D. C. Cronauer, R. O. Ruberto, and D. C. Young May 1979 110 p refs ,

(Contract EX-76-C-01-2305)

(FE-2305-30) Avail: NTIS HC A06/MF A01

An understanding of the mechanism of hydrogen transfer to coal and its intermediates during liquefaction was developed. Results of experiments with coal and asphaltenes are consistent with those of the model compounds, and the knowledge of both phases were combined. Coal primarily cracks in linkages between aromatic type units such that transferred hydrogen exists on carbons alpha to an aromatic ring. The coal free-radicals abstract hydrogen from any available source such as hydroaromatics, naphthenes, alkyl aromatics and dissolved hydrogen, in roughly that order. Solvent losses through adduction and isomerization were significant, and lead to decreased activity or effectiveness of recycled solvents. The use of nmr gives an improved understanding of the mechanism of reactions involved in the liquefaction of coal.

N80-32569# Filtrol Corp., Los Angeles, Calif.
DEVELOPMENT OF NEW CATALYSTS FOR COAL LIQUID
REFINING Quarterly Report, 1 Jan. - 31 Mar. 1980
Apr. 1980 28 p refs

(Contracts DE-AC01-78ET-12103; FT-78-C-01-2595) (FE-2595-\$; QR-5) Avail: NTIS HC AO3/MF A01

The first series of cracking catalysts formulated with 20% exchanged Na-Y zeolite, and 80% matrix binder was activity tested with a hydrotreating SRC-2 Fuel Oil Blend. The best results were obtained with a rare earth exchanged zeolite. An improved catalyst for hydrotreating SRC-2 Fuel Oil Blend was

prepared from a nickel molybdate impregnated Kaiser alumina. Synthesis and characterization of various catalytic components and cation exchange of these materials is complete.

N80-32570# Brookhaven National Lab., Upton, N. Y.
ADVANCED SYNFUELS PRODUCTION/POWER SYSTEMS
UTILIZING LASER PARTICULATE CONTROL

T. Botts, Jr., J. R. Powell, and J. A. Fillo 1979 4 p refs Presented at the 2d Miami Intern. Conf. on Alternative Energy Sources, Miami Beach, Fla., 10-13 Dec. 1979

(Contract DE-AC02-76CH-00016)

(BNL-27783; CONF-791204-38)

Avail: NTIS

HC A02/MF A01

Coal fired turbines offer an attractive means of generating electrical power using an available resource and near term technologies. However, in order to maintain adequate turbine blade lifetimes, and thus make such plants economically attractive, better means of hot gas clean up than those presently available are needed. One possible solution to this problem is the use of intense laser beams to augment the conventional body forces in cyclones to increase collector efficiencies for smaller sized particulates. Finally, plant factors can be increased by means of alternate energy utilization during offpeak periods. One such scheme is to raise steam and perform high temperature electrolysis. It appears as if the hydrogen produced is more useful as a transportable fuel or chemical than as a means of energy storage.

N80-32571# New Zealand Energy Research and Development Committee, Auckland.

AUTOMOTIVE FUELS FROM CELLULOSE MATERIALS Final Report

B. Higginson and R. H. Thornton Jan. 1980 28 p refs (NZERDC-49; ISSN-0110-1692) Avail: NTIS HC A03/MF A01

The results of this investigation showed that it was feasible to link the alcohol fermentation and anaerobic digestion processes into a system for the production of both alcohol and methane from organic substrates. Although optimization of fermentation was attempted with due regard to energy conservation, for industrial application the cost of sugar will be the overriding factor. A hydraulic retention time of 10 days or longer was needed for effective digestion in which a reduction of chemical oxygen demand of up to 85% was achieved. Results indicated that further reduction in retention time may be possible if the microbial biomass could be either retained on support media, or recycled more effectively. A gas production rate of 4270 liters gas/cubic meter culture/day at 11.6 day retention time was obtained with the anaerobic contact digester using fodder beet spent wash. Using the same substrate, results over short periods with the anaerobic filter system could produce up to 4.8 liters gas/litre culture/day. The high methane composition of this gas (75 to 80%) make this an attractive proposition.

N80-32572# Mechanical Technology, Inc., Latham, N. Y. ASSESSMENT OF SYNTHANE MECHANICAL EQUIPMENT J. T. McCabe, F. E. Kramberger, B. R. Hao, D. Dubis, and S. E. Carson May 1980 164 p refs (Contract DE-AC01-77ET-10622)

(MTI-79TR5) Avail: NTIS HC A08/MF A01

Mechanical equipment in the Synthane pilot plant was subjected to operating conditions outside manufacturers' specifications. In some cases, these encounters were intentional and in other cases they resulted from insufficient data. All 106 of the test runs were terminated involuntarily. For the most part, the repetitive failures of plant materials and equipment originated from a combination of excessive solids overloading and corrosion/erosion caused by abnormal conditions of operation on fluid process streams. The extremes of these conditions were not anticipated nor were they taken into consideration in the design of the plant and in the selection of equipment and materials. Because of this situation, approximately half of the test run terminations were directly attributed to mechanical failures. Generally, for reasons given the maintenance, repair or replacement of failed equipment was not successful in eliminating or

alleviating many failures until early 1978. Appropriate early planning can eliminate all these causes of failure in the future.

N80-32573# Los Alamos Scientific Lab., N. Mex. FLASH PYROLYSIS AND GASIFICATION OF COAL THROUGH LASER HEATING

W. H. Beattie and J. A. Sullivan 1980 6 p refs Presented at 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 18-22 Aug. 1980 (Contract W-7405-eng-36)

CONF-800806-28) (LA-UR-80-1094;

NTIS Avail:

HC A02/MF A01

Experimental results obtained from the rapid pyrolysis of finely powdered coal are presented. The experiments are designed to provide basic information on gas yield, gas composition, optimum fluxes, and temperature history of coal samples under high intensity laser radiation. The information obtained from these experiments is used to test concepts for the use of concentrated sunlight to produce fuel gases from coal. Heating the coal at rates of 1000 to 10,000 C/s in an inert atmosphere of argon results in pyrolysis at temperatures between 400 and 800 deg C. The gases evolved are primarily CO, H2, and CH4 with lesser amounts of CO2 and other light hydrocarbons. Mass spectrometry is used to determine the composition of the evolved gases. The optimum flux for laser pyrolysis of coal was found to be 250w /sq cm. Results from experiments wherein the char created by pyrolysis is gasified to CO in an atmosphere of CO2 are also presented.

N80-32574# Pace Co. Consultants and Engineers, Inc., Denver, Colo. Div. of Coal Conversion.

COAL LIQUEFACTION Quarterly Report, Apr. - Jun. 1979 Apr. 1980 65 p

(DOE/FE-0003/79-2) Avail: NTIS HC A04/MF A01

Current work is aimed at improved process configurations for both catalytic and non catalytic processes to provide more attractive processing economics and lower capital investment. The advantage of coal liquefaction is that the entire range of liquid products, especially boiler fuel, distillate fuel oil, and gasoline. can be produced from coal by varying the type of process and operating conditions used in the process. Furthermore coal derived liquids have the potential for use as chemical feedstocks. To provide efficient and practical means of utilizing, coal resources, DOE is supporting the development of several conversion processes that are currently in the pilot plant stage.

N80-32578\*# New Mexico Univ., Albuquerque. Application Center.

BIOMASS ENERGY PRODUCTION. CITATIONS FROM THE INTERNATIONAL AEROSPACE ABSTRACTS DATA BASE Progress Report, 1975 - Apr. 1980

Peter W. Moore Jun. 1980 58 p Sponsored in cooperation with NASA and NTIS

(PB80-810807;

NASA-CR-163595) Avail:

HC \$30.00/MF \$30.00 CSCL 21D

These 210 citations from the international literature describe the production and/or utilization of most forms of biomass as a source of energy, fuel, food, and chemical intermediates or feedstocks. Biomass conversion by incineration, gasification, pyrolysis, hydrolysis, anaerobic digestion, or fermentation, as well as by catalytic, photosynthetic, chemosynthetic, and bioelectrochemical means are among the conversion processes considered. Discussions include biomass plantation and material productivity, transportation and equipment requirements, effects, comparisons of means and efficiencies of utilization and conversion, assessments of limitations, and evaluations of economic potential.

N80-32579# National Technical Information Service, Springfield,

SYNTHETIC FUELS FROM MUNICIPAL, INDUSTRIAL AND AGRICULTURAL WASTES. CITATIONS FROM THE AMERICAN PETROLEUM INSTITUTE DATA BASE Progress Report, 1978 - Apr. 1980

Audrey S. Hundemann Jul. 1980 165 p Supersedes NTIS/PS-79/0547; NTIS/PS-78/0500 (PB80-812365: NTIS/PS-79/0547: NTIS/PS-78/0500) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

The bibliography cites worldwide literature on the production of fuels from waste materials, such as animal manure, wood chips, sewage sludge, urban garbage, agricultural wastes, and old automobiles. This updated bibliography contains 159 citations. 57 of which are new entries to the previous edition.

N80-32581# National Technical Information Service, Springfield,

ALCOHOL FUELS. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - 1978

Diane M. Cavagnaro, Jun. 1980 227 p (PB80-812449) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 21D

The cited reports from a worldwide literature survey. includes such topics as blends, synthesis, processes used, properties, engine performance evaluations, economics, safety measures, pollution effects, and combustion studies. Also covered are the sources from which alcohol fuels can be obtained, such as coal, solid wastes industry byproducts, and agricultural waste. This updated bibliography contains 220 citations, none of which are new entries to the previous edition.

N80-32582# National Technical Information Service, Springfield.

ALCOHOL FUELS, CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Jun. 1980 Diane M. Cavagnaro Jul. 1980 163 p Supersedes NTIS/PS-79/ 0714; NTIS/PS-78/0674

(PB80-812456; NTIS/PS-79/0714; NTIS/PS-78/0674) Avail:

NTIS HC \$30.00/MF \$30.00 CSCL 21D

The cited reports from a worldwide literature survey discuss new technology in the field of alcohol fuels. The bibliography covers the different blends, synthesis, processes used, properties, engine performance evaluations, economics, safety measures, pollution effects, and combustion studies. The research also covers sources from which alcohol fuels can be obtained, such as coal, solid wastes, industrial by-products and agricultural wastes. This updated bibliography contains 156 citations, 21 of whch are new entries to the previous edition.

N80-32699# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, Idaho.

HEAT PUMPS IN LOW TEMPERATURE APPLICATIONS J. G. Keller 18 Aug. 1980 5 p refs Presented at 15th Intersoc. Energy Conversion Engr. Conf., Seattle, 18 Aug. 1980 (Contract DE-AC07-76ID-01570)

(CONF-800806-7) Avail: NTIS HC A02/MF A01 Methods of efficiency using the lower temperature geothermal

resources for space conditioning are presented. Water to air and water to water heat pumps for use with domestic or thermally marginal geothermal water in the 50 to 90 F (10 to 32 C) range are examined. Developments in geothermal resource utilization are presented. A diaphragm type heat pump for use with source temperatures as low as 40 C is discussed.

N80-32726# International Nickel Co., Inc., Suffern, N. Y. Research and Development Center.

WELD OVERLAYING FOR CORROSION RESISTANCE IN COAL GASIFICATION ATMOSPHERES Quarterly Report, 1 Mar. - 31 May 1979

Edward P. Sadowski 1979 65 p (Contract ET-77-C-01-2621)

(FE-2621-13) Avail: NTIS HC A04/MF A01

Hardness and tensile testing of weldments exposed to a 1% H2S coal gasification atmosphere for 1000 hours at 982 C was completed. Corrosion evaulation of unwelded specimens of 304L, 310 SS and INCOLOY alloy 800H was also completed. The INCONEL Filler Metal 72 and R139 overlays increased and the AWS-ER309 overlays decreased in hardness after exposure. The welding process used had very little effect on the response

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of the FM-72 overlays, while R139 deposited by the SAW process had the least increase in hardness. The latter may be associated with the lower AI recovery obtained with the SAW process. Generally, the heat affected zone and base metals of all weldments decreased in hardness after exposure. All weldness decreased in room temperature yield and tensile strength after exposure. Most weldments suffered a decrease in tensile ductility. The 310 weldments had the largest percentage decrease and the 3041 weldments the last percentage decrease in the original tensile ductility after exposure.

N80-32728# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

HIGH-TEMPERATURE TURBINE TECHNOLOGY PROGRAM.
OVERALL PLANT DESIGN DESCRIPTION (OPDD) COALDERIVED LIQUID

M. W. Horner Mar. 1980 192 p refs (Contract EX-76-C-01-1806)

(FE-1806-84) Avail: NTIS HC A09/MF A01

A highly reliable, commercially viable system based on coal-derived liquid fuel is described. A coal-derived liquid fueled, high firing temperature, water-cooled gas turbine system with a steam bottoming plant that has one reheat steam turbine is discussed. A detailed exposition of the organization, operation, and control of the integrated system is presented. The combined-cycle system specified provides improved flexibility of operation as well as reliability and efficiency. The PRD-6 gas turbine utilized in the system design has a 12:1 pressure ratio, compressor inlet air flow of 300 lb/second, and a 2600 F deg. firing temperature. The performance characteristics of the overall plant are given.

N80-32796# Wyoming Univ., Laramie. Energy Technology

NEW METHOD TO DETERMINE THE INDEPENDENT SHEAR MODULI OF TRANSVERSELY ISOTROPIC MATERIALS

K. P. Chong, J. L. Chen, K. Uenishi, and J. W. Smith 1980 15 p refs Presented at the 4th SESA Intern. Congr. on Exptl. Mech., Boston, 25-30 May, 1980

(Contract DE-AT20-80LC-10224)

(CONF-800575-1) Avail: NTIS HC A02/MF A01

A simple method is presented to determine the independent shear moduli of transversely isotropic materials. The method is tested on Green River Formation oil shale, one of such materials. The method is applicable for linear and nonlinear elastic materials. Mathematical formulation, derivation and solution are given, and test apparatus and results are presented. Comparison with other approximate results and acoustical methods are made. Confirmation of the test method with materials having known shear moduli is also presented.

N80-32837# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

REMOTE SENSING APPLIED TO THE PROSPECTING OF GEOTHERMAL ANOMALY IN CALDAS NOVAS COUNTY, STATE OF GOIAS, BRAZIL

Paulo Veneziani and Celio Eustaquio DosAnjos Jun. 1980 6 p refs Presented at the 14th Intern. Symp. on Remote Sensing of Environ., San Jose, Costa Rica, 23-30 Apr. 1980 (INPE-1792-RPE/164) Avail: NTIS HC A02/MF A01

Thermally anomalous areas associated with hot waters in the County of Caldas Novas, State of Goias, Brazil were studied. Data collection using a 50 cm soil thermometer and a Precision Radiation Thermometer indicated the presence of four principal anomalies. These areas were verified in the field. In the area of the town of Caldas Novas, of 14 deep wells drilled, none revealed water temperatures from 33 to 41 C, two contained hot mud, and one contained sulfurous water measured at 29 C. Two day wells were also encountered.

N80-3299# Exxon Research and Engineering Co., Linden, N.J. MINIPLANT AND BENCH STUDIES OF PRESSURIZED FLUIDIZED-BED COAL COMBUSTION Final Report, Aug. 1977 - Aug. 1979

R. C. Hoke, E. S. Matulevicius, M. Ernst, J. L. Goodwin, A. R. Garabrant, I. B. Radovsky, A. S. Lescarret, R. R. Bertrand, L. A. Ruth, and V. J. Siminski Jan. 1980 333 p refs (Contract EPA-68-02-1312)

(PB80-188121: EXXON/GRU.18GFGS.79; EPA-600/7-80-013) Avail: NTIS HC A15/MF A01 CSCL 07A

Results of studies on the environmental aspects of the pressurized fluidized-bed coal combustion process are given. The process uses kg coal/hr continuous combustion sorbent regeneration Miniplant (0.63 MW equivalent), and a 13 kg coal/hr bench-scale system.

# N80-33072# Battelle Pacific Northwest Labs., Richland, Wash. DEFINITION OF GUST MODEL CONCEPT AND REVIEW OF GUST MODELS

David C. Powell and James R. Connell Jun. 1980 100 p refs

(Contract DE-AC06-76RL-01830)

(PNL-3138) Avail: NTIS HC A05/MF A01

Four models are examined which attempt to describe wind fluctuations in relation to a wind energy conversion system that is subjected to these fluctuations observed from a fixed location within the atmospheric boundary layer. The primary purpose of this examination is to provide a basis for understanding present and future developments in gust and gust rise models. The examination is accomplished by identifying the gust definitions used in the models and relating them to a basic definition given.

N80-33520# Virginia Polytechnic Inst. and State Univ., Blacksburg.

DEVELOPMENT AND APPLICATION OF ANALYTICAL TECHNIQUES TO CHEMISTRY OF DONOR SOLVENT LIQUEFACTION Quarterly Progress Report, Jan. - Mar. 1980

H. C. Dorn and L. T. Taylor Jun. 1980 20 p (Contract DE-AC22-80PC-20041)

(DOE/PC-20041/T1) Avail: NTIS HC A02/MF A01

Elemental analyses (Mg. Al, P, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Sr, Zr, Mo, Cd, Ba, W, Hg) were measured on ashed samples of Amax feed coal and Amax solvent refined coal (SRC). Significant concentrations of most of the elements monitored were found. Since the SRC process is designed to remove mineral matter it is not surprising that the level of metal in SRC is lower than in the feed coal for many metals. Unexpectedly certain elements appear to be concentrated into the SRC product. Those metals where the concentration has diminished greatly (Ca, Al, Fe, and Mg) on going from raw coal to SRC are probably mineral related. There are numerous metals (Co., Zn., Cu., Ni., Cr., Mn., Cd) whose concentration is higher in SRC. These, we believe, are most likely organic related in SRC. This is not unreasonable since the group is 100% transition metals and it is these metals which are most likely to form organometallic species. Cobalt and zinc are especially noteworthy in this regard showing a threefold increase in concentration in SRC over the feedstock.

## N80-33675 British Library Lending Div., Boston Spa (England). THE PRESSURIZED FLUIDIZED BED GASIFICATION OF COAL CHAR

S. Honma Jun. 1980 12 p ref Transl. into ENGLISH from Nenryo Kyokai-shi (Japan), v. 58, no. 3, 1979 p 219-224 (BLL-RTS-12347) Avail: British Library Lending Div., Boston Spa, England

Experiments on the pressurized fluidized bed gasification of Pacific coal char are described and the relation between operating factors, such as pressure and feed rate of air, and the calorific value of the gas produced and the throughput of material is classified. The relation between carbon utilization and heat conversion ratio is discussed.

N80-33576 British Library Lending Div., Boston Spa (England). THE FLUIDIZED BED GASIFICATION OF COAL CHAR Y. Tazaki and J. Kawabata Jun. 1980 14 p refs Transl. into ENGLISH from Nenryo Kokaishi (Japan), v. 58, no. 3, 1979

p 212-218

(BLL-RTS-12346) Avail: British Library Lending Div., Boston

Spa, England

The effect of oxygen concentration of the gasification agent on sintering of ash was investigated. Ash resisted sintering when the oxygen concentration of the gasification agent was reduced. Sintering did not occur at gasification temperatures as high as 1050 C, despite the presence of oxygen, when silica sand was used as fluidizing medium. A gasification process was examined in which the fluidized bed was divided into two stages with a horizontal perforated plate, the first stage functioning as a coal combuster with silica sand as fluidizing medium and the second stage functioning as a coal gasifier utilizing heat from the first stage. Sintering of ash in the first stage was prevented by the silica sand, while in the second stage the partial pressure of oxygen in the gasification agent was virtually zero, and the ash failed to sinter notwithstanding gasification at temperatures up to 1050 C.

R.K.G.

N80-33577 Texas Univ. at Austin.

MODELING OF HEAT AND MASS TRANSFER DURING COAL BLOCK GASIFICATION Ph.D. Thesis

Tat Hang Tate Isang 1980 209 p

Avail: Univ. Microfilms Order No. 8021523

The drying of coal, pyrolysis of small coal particles and gas-char reactions are discussed in the content of diffusion and flow of gases in the pyrolyzing coal (porous media). Sophisticated models for drying of a coal block and for diffusion and flow of multi component gaseous mixture through the porous coal matrix are developed and simplifying assumptions are discussed.

Dissert. Abstr.

N80-33578 Illinois Univ. at Chicago Circle, Chicago.
SINGLE PARTICLE GAS-SOLID REACTIONS AND THEIRAPPLICATION TO MODELING OF FLUIDIZED BED COAL
COMBUSTORS AND ASH AGGLOMERATING GASIFIERS
Ph.D. Thesis

Amirali G. Rehmat 1980 336 p

Avail: Univ. Microfilms Order No. 8023250

The material and energy balances derived during single and multiple gas solid reactions that take place on a single particle are utilized to (1) model the char combustion, (2) model the gasification of char, (3) establish the conditions for ash agglomeration during combustion and gasification, and (4) verify the direct oxidation model for char combustion. The shrinking core model was employed. The reaction resistances accounted for include the intraparticle diffusion resistance, the intermolecular diffusion resistance, the reaction rate, and the interphase diffusion. Analysis of single and multiple gas solid reactions revealed that the particle growth has a significant influence on reaction time when the diffusion resistance controls the overall rate of reaction. The solution of the unsteady state heat balance equation shows that the particle core temperature is greatly influenced by the heat of reaction, the size of the particle, the partial pressure of the gaseous reactant, the particle growth factor, and the ambient temperature. This information is translated into the design of an ash agglomerating coal gasifier and extended to modeling of the fluidized bed processes. Dissert. Abstr.

N80-33679# Chemical Engineering Research Group, Pretoria (South Africa).

PREPARATION AND STABILITY OF EMULSIONS OF METHANOL IN AUTOMOBILE DIESEL OIL

C. G. McCormack Oct. 1979 32 p refs

(CSIR-CENG-294: ISBN-0-7988-1730-5) Avail: NTIS HC A03/MF A01

Short term emulsification of up to 20% methanol in diesel oil (stability lasting a few hours) is feasible but the emulsifiers successful in this respect are costly and have to be applied in relatively high concentrations. No emulsifier was found which produces an emulsion with long term stability; mutual solubilities of the various components and solubility changes with temperature were identified as the most important causes. It is unlikely than an emulsifier will be found which produces stable temperature insensitive emulsions of methanol in diesel oil. Even if such a emulsifier exists, the required amount of and costs are expected to be prohibitive in a fuel application.

N80-33599# Stone and Webster Engineering Corp., Boston, Mass.

HYDROPROCESSING OF LIGHT PYROLYSIS FUEL OIL FOR KEROSENE TYPE JET FUEL Final Report, 1 Oct. 1978 - 31 Oct. 1979

Alexander Korosi and J. N. Rubin Feb. 1980 70 p refs (Contract F33615-78-C-2074)

(AD-A089101; S/W-PROC-111579; AFWAL-TR-80-2012) Avail: NTIS HC A04/MF A01 CSCL 21/4

The feasibility of converting light pyrolysis fuel oil (a steam cracking by-product) into jet fuel was assessed. The raw aromatic fuel oil was hydrostabilized and converted into naphthenic products by hydrogenation in pilot plant operation. The fully hydrogenated fuel showed excellent cold properties, high heat of combustion values on volume basis and met nearly all specifications on kerosene-type fuels. Conceptual process design and related economics indicated the product cost was competitive with other petroleum products. This fuel is a new potential source for JP5 or JP8 kerosene type jet fuel.

N80-33601# United Technologies Corp., South Windsor, Conn. Power Systems Div.

COAL GASIFICATION COMBINED-CYCLE SYSTEM ANALYSIS Final Report

S. Hamilton, J. Garow, and S. J. Lehman Apr. 1980 178 p. refe

(EPRI Proj. 986-2)

(EPRI-AP-1390) Avail: NTIS HC A09/MF A01

The results of a study involving combustion turbine power plants using coal gasification are summarized. Systems integration and the optimization of power plant conceptual design were studied. The objectives include: (1) determining potential levels of thermal efficiency for well integrated gasified coal combined cycle systems; (2) quantifying the effects of varying key design parameters of various components on overall plant performance; and (3) project potential levels of performance made possible by using advanced, combustion turbines and advanced gasifiers. Emphasis was placed on effective waste heat management and practically in synthesizing overall power plant arrangements. Current technology systems were defined which yielded thermal efficiencies in the range of 35 to 37%. It was found that approximately one percentage point in thermal efficiency could be realized by using either the British Gas Corporation (BGC) slagging, fixed bed gasifier or the air blown Texaco gasifier in place of the oxygen blown Texaco gasifier. Two percentage points were gained by increasing the gas turbine combustor exit temperature about 300 F.

N80-33602# JBF Scientific Corp., Wilmington, Mass. EVALUATION OF PROCESSES FOR PRODUCING GASO-LINE FROM WOOD Final Report

May 1980 50 p refs

(Contract DE-AC01-79PE-70048)

(DOE/PE-70048/T2) Avail: NTIS HC A03/MF A01

Three processes for producing gasoline from wood by pyrolysis were investigated. Technical and economic comparisions among the processes were made, based on a hypothetical common plant size of 2000 tons per day green wood chip feedstock. Perspective is provided by comparisons of the wood to gasoline technologies with other similar systems, including coal to methanol and various biomass to alcohol systems. Several descriptions of energy efficiency were used, but all showed that methanol production from wood, with or without subsequent processing by the Mobil route to gasoline, appears most promising, however, the critical wood to methanol system remains conceptual. Another observation was that the ethanol production systems appear inferior to the wood to gasoline processes.

N80-33606# Santa Clara Univ., Calif. Dept. of Mechanical Engineering.

METHANOL/ETHANOL/GASOLINE BLEND FUELS DEM-ONSTRATION WITH STRATIFIED CHARGE ENGINE VEHICLES Final Report

R. Pefley, H. Adelman, and T. Suga Mar. 1980 135 p refs

Prepared for California Energy Commission, Sacremento (PB80-192123; CAEC-49) Avail: NTIS HC A07/MF A01 CSCL 21D

The performance of four 1978 Honda CVCC vehicles was monitored over a twelve month period. Three of the unmodified vehicles were fueled with alcohol/gasoline blends (5% methanol, 10% methanol, and 10% ethanol) with the fourth remaining on gasoline as a control. The demonstration and testing established the following: (1) the tested blends cause no significant degradation in exhaust emissions, fuel economy, and driveability: (2) the tested blends cause significant increases in evaporative emissions: (3) analysis of periodic oil samples shows no evidence of accelerated metal wear: and (4) higher than 10% alcohols will require substantial modification to most existing California motor vehicles for acceptable emissions, performance, and fuel. economy.

# N80-33920# California Energy Commission, Sacramento. URANIUM RESOURCES: A REVIEW OF ESTIMATION METHODOLOGIES Final Consultant Report Stephen J. Sullivan May 1980 71 p refs

(PB80-193725; CAEC-50; CAEC-300-80-025) Avail: NTIS HC A04/MF A01 CSCL 10A

Several methods for estimating recoverable resources which fall into two categories. Explicit models yield the amount and distribution of uranium ore on the basis of a known physical characteristic, such as rock type. Implicit models yield resources on the basis of an historical trend, such as annual production over time. Other methods are used to estimate subeconomic deposits. None of the methods are identified, and recent resource estimates are presented.

# N80-33921# California Energy Commission, Sacramento. THE POTENTIAL OF ENERGY FARMING IN THE SOUTHEASTERN CALIFORNIA DESERT Final Staff Report

Virginia Lew Apr. 1980 64 p refs (PB80-195019: CAEC-66: CAEC-500-80-017) Avail: NTIS HC A04/MF A01 CSCL 21D

The use of energy forms to provide future sources of energy for California is considered. Marginal desert lands in southeastern California are proposed for the siting of energy farms using acacia, eucalyptus, euphorbia, guayule, jojoba, mesquite, or tamarisk.

GR4

N80-33950# City Council of Cape Town (South Africa). Electricity Dept.

#### MUNICIPAL REFUSE AS A FUEL FOR POWER GENERA-TION

B. D. Ives In CSIR Intern. Conf. on Air Pollution, Vol. 3 25 Oct. 1979 16 p refs

#### Avail: NTIS HC A16/MF A01

The utilization of municipal refuse as a fuel by various power generating authorities was investigated. The economic and practical aspects of burning refuse were considered together with the solutions adopted for overcoming the serious problems initially experienced.

R.C.T.

## N80-33952# City of Port Elizabeth (South Africa). UTILIZATION OF MUNICIPAL REFUSE AS AN ENERGY SOURCE

R. J. Lawrence In CSIR Intern. Conf. on Air Pollution, Vol. 3 25 Oct. 1979 13 p

#### Avail: NTIS HC A16/MF A01

The utilization of municipal wastes for energy purposes is considered as a possible alternative to the shortage and high cost of traditional fossil fuels. Specific emphasis is given to examining the past and future developments of this aspect of energy technology.

R.C.T.

N80-33988 Texas Univ. at Austin.
A MULTI-SITE MAGNETOTELLURIC MEASUREMENT
SYSTEM WITH REAL TIME DATA ANALYSIS

Ph.D. Thesis

James David Becker 1980 191 p Avail: Univ. Microfilms Order No. 8021400

A magnetotelluric measurement system was designed to provide a more cost effective electrical method for geothermal and mineral exploration. The theoretical requirements and sensitivities of the magnetotelluric inversion process were specifically addressed in determining system performance requirements. Significantly reduced instrument noise levels provided improved data quality, and simultaneous measurement at up to six locations provided reduced cost per site.

Dissert. Abstr.

# N80-34020 Texas A&M Univ., College Station. CHANGES IN THE POTENTIAL FOR WIND ENERGY GENERATION DUE TO TERRAIN MODIFICATION OF THE BOUNDARY-LAYER FLOW Ph.D. Thesis

James Elwood Arnold, Jr. 1980 158 p Avail: Univ. Microfilms Order No. 8023013

In situ measurements and a wind tunnel experiment were used to define the degree of wind speedup in the boundary-layer flow over the top of a small mesa. Measurements of the speedup of the wind relative to that observed over level terrain at the same height above the ground are presented as a function of distance from the windward edge of an escarpment. These results are shown for neutral as well as stable atmospheric conditions. It was found that the wind tunnel measurements, in situ measurements, and existing two dimensional models of the terrain modification of scarpment flow agreed well for neutral conditions but differed considerably when stable conditions existed at the mesa site.

Dissert. Abstr.

N80-34052# National Weather Service, Salt Lake City, Utah. Western Region.

#### THE SWAB (SPECTRAL WAVE AND BAR) PROGRAM

Morris Webb, S., Jr. (Weather Service Forecast Office, San Francisco) Mar. 1980 36 p refs Sponsored by NOAA (PB80-196041: NOAA-NWS-WRCP-9; NOAA-80051302) Avail: NTIS HC A03/MF A01 CSCL 08C

The SWAB (Spectral Wave and Bar) program allows the wave forecast technique developed by the School of Oceanography at Oregon State University to be used in AFOS. Variables describing the SWAB to produce a forecast out to 48 hours of significant wave height and period at a given point. This forecast along with data from the National Ocean Survey's Tidal Current Tables, is used to predict bar conditions at a time of maximum ebb current at several locales.

N80-34093\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### HEALTH REQUIREMENTS FOR ADVANCED COAL EXTRACTION SYSTEMS

Wayne F. Zimmerman 15 Sep. 1980 28 p refs (Contracts NAS7-100: DE-Al01-76ET-12548) (NASA-CR-163265; JPL-Pub-80-72) Avail: HC A03/MF A01 CSCL 06J

Health requirements were developed as long range goals for future advanced coal extraction systems which would be introduced into the market in the year 2000. The goal of the requirements is that underground coal miners work in an environment that is as close as possible to the working conditions of the general population, that they do not exceed mortality and morbidity rates resulting from lung diseases that are comparable to those of the general population, and that their working conditions comply as closely as possible to those of other industries as specified by OSHA regulations. A brief technique for evaluating whether proposed advanced systems meet these safety requirements is presented, as well as a discussion of the costs of respiratory disability compensation.

Autho

NTIS

N80-34117# Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Bad Godesberg (West Germany). Inst. for the Dynamics of Flight Systems.

THE USE OF COMPUTER-CONTROLLED MANIPULATORS IN UNDERWATER TECHNOLOGY

Lothar Schmeider In ESA Contrib. to the Symp.: Computer Sci. in Space Flight .(ESA-TT-587) Feb. 1980 p 59-72 refs Transl. into ENGLISH of "Beitraege zum Symp.: Datentechnik in der Raumfahrt", Rept. DFVLR-Mitt-78-02 DFVLR, Oberpfaffenhofen, West Germany. Oct. 1978

(DFVLR-Mitt-78-02) Avail: NTIS HC A07/MF A01; DFVLR, Cologne DM 53.50

Possible applications of manipulators in underwater technology, and particularly in off-shore oil drilling, are reviewed. Reference is made to an underwater laboratory able to dive to depths of up to 100 m, and work being done for extending the diving depth to 600 m. A computer controlled external manipulator for more flexible and effective operation is discussed.

Author (ESA)

N80-34239# Sandia Labs., Albuquerque, N. Mex. Pulsed Power System Dept.

## PULSED POWER ACCELERATORS FOR PARTICLE BEAM FUSION

T. H. Martin, G. W. Barr, J. P. VanDevender, R. A. White, and D. L. Johnson 1980 5 p refs Presented at the 14th Pulse Power Modulator Symp., Orlando, Fla., 3 Jun. 1980 (Contract DE-AC04-76DP-00789)

(SAND-80-0550C; CONF-800640-12) Avail: NTIS

HC A02/MF A01

Sandia National Laboratories is completing the construction phase of the Particle Beam Fusion Accelerator 1 (PBFA-1). Testing of the 36 module, 30 TW, 1 MJ output accelerator is in the initial stages. The 4 MJ, PBFA Marx generator provided 3.6 MA into water-copper sulfate load resistors with a spread from first to last Marx firing between 15 to 25 ns and an output power of 5.7 TW. This accelerator is a modular, lower voltage, pulsed power device that is capable of scaling to power levels exceeding 100 TW. The elements of the PBFA technology and their integration into an accelerator system for particle beam fusion is discussed.

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Includes photovoltaic, thermoelectric, geothermal, ocean thermal, and wind energy conversion. Also includes nuclear reactors and magnetohydrodynamic generators.

A80-43972 Grad B focusing and deposition of relativistic electron beams. J. A. Halbleib, Sr., T. P. Wright (Sandia Laboratories, Albuquerque, N. Mex.), and S. A. Goldstein (Jaycor, Inc., Alexandria, Va.). Physical Review Letters, vol. 45, Aug. 4, 1980, p. 344-346, 7 refs. Contract No. DE-AC04-76DP-00789.

Grad B transport, bunching, and focusing of relativistic electron beams give power deposition levels which may provide the absorbed fluxes of 100 TW/sq cm believed necessary to drive breakeven inertial-confinement-fusion targets. Predicted depositions in excess of 100 (TW/g)/MA are presented. These levels are up to two orders of magnitude higher than those previously calculated and appear to meet the absorbed-flux requirement. (Author)

A80-43973 Energy principle with global invariants for toroidal plasmas. A. Bhattacharjee, R. L. Dewar, and D. A. Monticello (Princeton University, Princeton, N.J.). Physical Review Letters, vol. 45, Aug. 4, 1980, p. 347-350. 9 refs. Contract No. DE-AC02-76CH-03073.

A variational principle is proposed for constructing equilibria with low free energy in toroidal plasmas in which relaxation is dominated by a tearing mode of single helicity. States with current density vanishing on the boundary are constructed. Theoretical predictions are compared with experimental data from reversed field pinches and tokamaks. (Author)

A80-44104 \* # Low cost composite materials for wind energy conversion systems. O. Weingart (Structural Composites Industries, Inc., Azusa, Calif.). International Solar Energy Society, Annual Meeting, Phoenix, Ariz., June 1-6, 1980, Paper. 6 p. Contract No. DEN3-100.

A winding process utilizing a low-cost E-glass fabric called transverse-filament tape for low-cost production of wind turbine generators (WTG) is described. The process can be carried out continuously at high speed to produce large one-piece parts with tapered wall thicknesses on a tapered mandrel. It is being used to manufacture blades for the NASA/DOE 200-ft-diameter MOD-1 WTG and Rockwell/DOE 40-kW small wind energy conversion system (SWECS).

V.T.

A80-44106 \* # Parametric study of prospective early commercial OCMHD power plants /PSPEC/. C. H. Marston, D. J. Bender, J. G. Hnat, and T. C. Dellinger (General Electric Co., Advanced Energy Dept., Philadelphia, Pa.). International Conference on Magneto-Hydrodynamic Electrical Power Generation, 7th, Massachusetts Institute of Technology, Cambridge, Mass., June 16-20, 1980, Paper. 7 p. 17 refs, Contract No. DEN3-52.

The paper presents a parametric study conducted to obtain the performance, economics, natural resource requirements, and environmental impact of moderate technology MHD/steam power plants that do not require development of direct-fired high-temperature air heaters. The study was divided into three base cases, each with a reference case and parametric variations. The case using recuperative air preheat in the range of 1000 F to 1300 F, combined with O2 enrichment to 42% by volume has been selected for conceptual design.

V.T.

A80-44107 \* # Results from study of potential early commercial MHD power plants and from recent ETF design work. F. Hals, R. Kessler, D. Swallom, L. Westra, J. Zar (Avco Everett Research Laboratory, Inc., Everett, Mass.), W. Morgan (Charles T. Main, Inc., Boston, Mass.), and C. Bozzuto (Combustion Engineering, Inc.,

Windsor, Conn.). International Conference on Magnetohydrodynamic Electrical Power Generation, 7th, Massachusetts Institute of Technology, Cambridge, Mass., June 16-20, 1980, Paper. 8 p. Contract No. DEN3-51.

The study deals with different 'moderate technology' entry-level commercial MHD power plants. Two of the reference plants are based on combustion of coal with air preheated in a high-temperature regenerative air heater separately fired with a low-BTU gas produced in a gasifier integrated with the power plant. The third reference plant design is based on the use of oxygen enriched combustion air. Performance calculations show that an overall power plant efficiency of the order of 44% can be reached with the use of oxygen enrichment.

A80-44126 # Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector. T. H. Gawain and O. Biblarz (U.S. Naval Postgraduate School, Monterey, Calif.). American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 13th, Snowmass, Colo., July 14-16, 1980, Paper 80-1341. 17 p. 12 refs. Research supported by the U.S. Department of Energy.

The operation of an electrohydrodynamic (EHD) power operator with both a single and a two-fluid ejector is studied. The single fluid is water while the two-fluid is a mercury/hydrogen combination. A complete thermodynamic analysis including compressibility and various estimates of losses is presented. The results confirm the fact that the electrical breakdown limitation is severe even at higher pressures. Furthermore, the single fluid is incapable of operating with any reasonable efficiencies even if the breakdown limitation is alleviated. The two fluid combination shows some promise provided that the breakdown strength can be increased by a factor of about five at the operating pressures. (Author)

A80-44185 # Magnetoplasma compressor with an explosion-driven magnetic power generator (Magnitoplazmennyi kompressor s vzryvomagnitnym generatorom energii). V. V. Vladimirov, I. I. Divnov, N. I. Zotov, A. S. Kamrukov, N. P. Kozlov, P. A. Ovchinnikov, Iu. S. Protasov, and B. D. Khristoforov (Moskovskoe Vysshee Tekhnicheskoe Uchilishche, Moscow, USSR). Zhurnal Tekhnicheskoi Fiziki, vol. 50, July 1980, p. 1521-1524. In Russian.

The applicability of explosion-driven magnetic generators as power sources for high-current discharges in magnetoplasma compressors was studied experimentally. An explosion-driven magnetic generator was found to be a power source of satisfactory efficiency in experiments with high-current radiant discharges.

V.P.

A80-44231 # Closed cycle MHD power plant and retrofit optimization application. J. C. Cutting, W. R. Owens, P. R. Sheth (Gilbert Associates, Inc., Reading, Pa.), J. Griswold, and M. Wehrey (Southern California Edison Co., Rosemead, Calif.). International Conference on Magnetohydrodynamic Electrical Power Generation, 7th, Massachusetts Institute of Technology, Cambridge, Mass., June 16-20, 1980, Paper. 9 p. 11 refs.

The results of two independent studies of closed-cycle MHD power systems are presented. A combined cycle consisting of an MHD closed-cycle topping unit retrofitted to an existing steam bottoming plant is considered. Preliminary results of an ongoing parametric study of an MHD closed-cycle system utilizing an integrated pressurized coal gasifier are discussed.

V.T.

A80-44239 \* # Experiments on H2-O2 MHD power generation. J. M. Smith (NASA, Lewis Research Center, Cleveland, Ohio). International Association for Hydrogen Energy, World Hydrogen Energy Conference, 3rd, Tokyo, Japan, June 23-26, 1980, Paper. 16

MHD power generation experiments utilizing a cesium-seeded H2-O2 working fluid have been carried out using a diverging area Hall

duct having an entrance Mach number of 2. The experiments are conducted in a high-field strength cryomagnet facility at field strengths up to 5 tesla. The effects of power takeoff location, axial duct location within the magnetic field, generator loading, B-field strength, and electrode breakdown voltage were investigated. For the operating conditions of these experiments it is found that the power output increases with the square of the B-field and can be limited by choking of the channel or interelectrode voltage breakdown which occurs at Hall fields greater than 50 volts/insulator. (Author)

A80-44343 # CT-6 tokamak research - Development and test operation of the experimental device. Acta Physica Sinica, vol. 29, May 1980, p. 577-587. In Chinese, with abstract in English.

The paper describes the design and operation of the CT-6 tokamak with a toroidal magnetic field of 2TL and plasma current of 30 kA. It produced a stable hot toroidal plasma of 250 eV; it consists of an electromagnetic toroidal, ohmic heating, and equilibrium field magnetic system, and an ultrahigh vacuum system (toroidal vestel and pumping device), power supply and a diagnostic instrumentation.

A.T.

A80-44390 Linear analysis of the double-tearing mode. P. L. Pritchett, Y. C. Lee (California, University, Los Angeles, Calif.), and J. F. Drake (Maryland, University, College Park, Md.). *Physics of Fluids*, vol. 23, July 1980, p. 1368-1374. 21 refs. NSF Grants No. PHY-79-01319; No. PHY-77-12873; Contracts No. DE-AM03-76SF-00010-PA-26; No. DE-AC05-7918-53044; No. N00014-79-C-0665. DOE Task III.

In the present paper, the linear behavior of the double-tearing mode (which can exist whenever the plasma has multiple rational surfaces) is analyzed within the framework of magnetohydrodynamics. A two-space-scale analysis, in which resistive solutions valid near the rational surfaces are joined to ideal solutions outside these regions, is performed and used to derive the dispersion relation for the double-tearing mode.

V.P.

A80-44429 On fusion alpha-particle heating of plasma below ignition. S. E. Segre (EURATOM and Comitato Nazionale per l'Energia Nucleare sulla Fusione, Frascati, Italy). *Nuovo Cimento B, Serie 11*, vol. 58B, July 11, 1980, p. 86-100. 6 refs.

The effect of alpha-particle heating is considered in a plasma which approaches but has not reached fusion ignition. Attention is given to the temperature increase due to tritium operation, the minimum temperature which ensures the accessibility of ignition, the conditions for purely Ohmic ignition and the time required for heating to fusion temperatures. A simple heating model is presented, and it is found that when alpha-particle heating is included for subignited plasma, the n tau, T performance which ensures that ignition can be reached with additional power is appreciably less restrictive than that required by the usual ignition condition. J.P.B.

A80-44599 Ocean thermal energy conversion - A general introduction. A. Lavi (Carnegie-Mellon University, Pittsburgh, Pa.). Energy (UK), vol. 5, June 1980, p. 469-480. 11 refs.

The ocean thermal energy conversion (OTEC) concept is discussed with emphasis on the closed Rankine cycle using ammonia as a working fluid. The main features of OTEC, such as low efficiency high flow rates, and high capital cost are put in perspective in terms of energy cost at the bus bar. Sensitivity analyses of net output power to key design variables and to performance uncertainty are performed. It is concluded that even with a large error in estimating performance conditions, the plant produces net output power. This indicates the robust nature of current designs. Finally, cost figures of major system components are given and electricity cost based on a hypothetical capital cost is computed. (Author)

A80-44600 OTEC research in Japan. H. Kamogawa (Toshiba Corp., Toshiba Research and Development Center, Kawasaki, Japan). *Energy* (UK), vol. 5, June 1980, p. 481-492. 8 refs.

The OTEC research in Japan carried out since 1970 is described. Design and cost estimates of the model 100 MW OTEC plants, two OTEC power loop experiments, and the development of new heat exchangers have been completed. Evaluation of OTEC thermal resources and the assessment of the OTEC concept as a power system have been made. However, these activities are still in the early stage, and a large amount of work is needed before OTEC power plants can contribute to Japan's energy demands.

A80-44601 Westinghouse OTEC power systems. W. H. Coleman, Energy (UK), vol. 5, June 1980, p. 493-501.

OTEC R&D in the U.S. has been focused mainly on the closed cycle with ammonia as the working fluid. The open cycle offers a number of advantages, including cost competitiveness. The two important features are in turbine protection in case of load loss and in the absence of evaporator biofouling. The Westinghouse opencycle concept departs from earlier approaches which locate deaeration ahead of the flash evaporator. Westinghouse proposes to allow all noncondensibles to flow into the condenser. This paper summarizes the main features of both the closed- and open-cycle concepts and provides systematic discussion of performance features and cost.

A80-44602 The mist-lift OTEC cycle. A. F. Charwat (California, University, Los Angeles, Calif.) and S. L. Ridgway (R & D Associates, Marina del Rey, Calif.). *Energy* (UK), vol. 5, June 1980, p. 511-524. 9 refs. Research sponsored by the U.S. Department of Energy.

The thermodynamics and implementation of the mist-lift concept for the generation of power from thermal gradients in warm oceans are analyzed. The main feature of this concept is that it permits an open cycle to operate on the ambient sea-water using state-of-the-art hydraulic turbines. An experimental facility being completed at UCLA is briefly described. (Author)

A80-44603 Thermal resource availability. P. M. Wolff (Ocean Data Systems, Inc., Monterey, Calif.) and L. F. Lewis (U.S. Department of Energy, Div. of Solar Technology, Washington, D.C.). Energy (UK), vol. 5, June 1980, p. 525-528. 15 refs.

The paper discusses thermal resource availability from ocean thermal energy conversion (OTEC) power plants. These plants require an ocean temperature difference sufficient to operate turbines as efficiently as possible. Ocean Data Systems (ODSI) assembled an ocean temperature data base for OTEC purposes for the NSF. From these data, summaries were prepared identifying seasonal OTEC thermal gradients for ocean areas surrounding the North American Continent. Under the Energy Research and Development Administration program, ODSI updated the historical file and identified the thermal resource for many specific sites on a monthly basis. Two charts of the world's oceans showing the gross resource available at depths of 500 and 1000 m are presented.

A80-44604 An update of OTEC baseline design costs. P. A. Curto (Mitre Corp., McLean, Va.). *Energy* (UK), vol. 5, June 1980, p. 529-538. 14 refs.

The paper discusses the relative economics of several OTEC mission concepts. The present and projected costs of alternative energy sources and manufactured products are compared to those for products manufactured by potential OTEC systems. The primary competitors for OTEC are baseload and intermediate electric power plants, coal-produced synthetic products, and materials made with oil and gas. There are technical and economic uncertainties regarding OTEC commercialization; in order for OTEC to acquire a substantial share of energy markets, these uncertainties which include the structural interface between the cold water pipe and the platform, the manufacturing of cost-effective heat exchangers, and corrosion of heat exchanger materials must be resolved.

A80-44605 Modelling the competitiveness of first generation commercial OTEC power plants. R. J. Pont (Lockheed Missiles

and Space Co., Inc., Sunnyvale, Calif.). *Energy* (UK), vol. 5, June 1980, p. 539-549. 16 refs.

The paper evaluates the prospective competitiveness of OTEC by comparing the delivered cost of electricity generated by the three types of plant for a geographical scenario typical of the region. The comparison is carried out using a modified version of the cost of energy model developed by the JPL, using current estimates of future construction, operating, and maintenance costs for the three plant types. Four variables were considered: OTEC plant capital costs, real fuel escalation costs, real cost of capital resources, and OTEC plant operating capacity factors. It was found that the first two factors are the prime determinants in OTEC competitiveness; it is forecast that OTEC plants should deliver electricity at roughly the same cost as nuclear and coal-fired power plants by the year 2000.

A.T.

A80-44606 Issues in OTEC commercialization. G. H. Lavi (Energy R&D International, Inc., Pittsburgh, Pa.). Energy (UK), vol. 5, June 1980, p. 551-560. 9 refs.

The paper discusses commercialization of OTEC which requires coordination between government and industry. Government regulation of the energy industry can either hinder its commercial development, or provide a financial incentive to induce industry investment. Incentives will be necessary in the early phases of OTEC both for the manufacturers of OTEC systems and for the owner-operators of OTEC power plants. The various incentives are analyzed and their impact on manufacturers and users of OTEC technology is discussed. The analysis shows that OTEC is technically and economically ready to enter the electric utility market in tropical islands. For the larger U.S. mainland market, economics of scale are expected to reduce the capital cost to a low enough level where OTEC can be competitive.

A80-44607 Introducing OTEC to mainland utilities. A. Lavi (Carnegie-Mellon University, Pittsburgh, Pa.) and D. G. Jopling (Florida Power and Light Co., Miami, Fla.). *Energy* (UK), vol. 5, June 1980, p. 561-569.

The paper examines major factors which a large utility considers in evaluating a potentially important new energy system. The U.S. electric utility experience with technological innovation was reviewed and the major problem areas identified from the utility's point of view. The feasibility and appeal of OTEC technology are discussed, and the steps which the utility takes in determining the need for new capacity and the planning which results in the construction and operation of a new plant are described. It was tentatively concluded that the current U.S. Government OTEC program leaves OTEC an unlikely candidate for meaningful U.S. mainland application within this century; a specific development strategy which will produce performance and cost data needed by potential investors and operators of electric utilities are recommended.

A80-44656 Neutral-beam energy and power requirements for expanding-radius and full-bore start-up of tokamak reactors. W. A. Houlberg, S. E. Attenberger, and A. T. Mense (Oak Ridge National Laboratory, Oak Ridge, Tenn.). *Nuclear Fusion*, vol. 20, July 1980, p. 811-820. 20 refs. Contract No. W-7405-eng-26.

Neutral-beam power and energy requirements are discussed for full-density, full-bore, and expanding-radius start-up scenarios in an elongated plasma as a function of beam pulse time and plasma density. A brief summary of the physics models is presented. A series of parameter surveys for start-up of a reactor plasma at constant density is analyzed. The applicability of an expanding-radius scheme to start-up of a large power-producing tokamak is outlined. V.T.

A80-44657 Particle confinement scaling experiments in the Culham Levitron. T. Edlington, W. H. W. Fletcher, A. C. Riviere, and T. N. Todd (Atomic Energy Research Establishment, Culham Laboratory, Abingdon, Oxon, England). *Nuclear Fusion*, vol. 20, July 1980, p. 825-831: 22 refs.

A single empirical scaling law for particle confinement experimentally established for both heated and unheated decaying plasmas is presented. It is shown that the scaling law at low temperatures has a classical-like form similar to that observed in the low-temperature regime in FM1 at Princeton (1972). However, the dependence on magnetic shear is found to be stronger, and up to electron temperatures of 2 eV, no evidence of Bohm scaling is found. V.T.

A80-44659 Combined n equal to 0 and n not equal to 0 MHD stability analysis of axisymmetric surface current model equilibria. E. Rebhan (Max-Planck-Institut für Plasmaphysik, Garching; Düsseldorf, Universität, Düsseldorf, West Germany) and A. Salat (Max-Planck-Institut für Plasmaphysik, Garching, West Germany). Nuclear Fusion, vol. 20, July 1980, p. 839-847. 23 refs. Research supported by the Deutsche Forschungsgemeinschaft and EURATOM.

The study deals with a combined n equal to 0 and n not equal to 0 MHD stability analysis carried out for a surface current model (SCM) of axisymmetric equilibria with constant plasma pressure. Emphasis is placed on the search of completely MHD-stable configurations which have beta-values as large as possible. These configurations are compared with simpler standard configurations.

v.T.

A80-44661 The feasibility of pellet re-fuelling of a fusion reactor. C. T. Chang, L. W. Jorgensen, P. Nielsen (EURATOM and Riso National Laboratory, Roskilde, Denmark), and L. L. Lengyel (EURATOM and Max-Planck-Institut für Plasmaphysik, Garching, West Germany). *Nuclear Fusion*, vol. 20, July 1980, p. 859-893. 104 refs.

The required refueling rate, reasonable pellet size, and dominant energy fluxes affecting an ablation process are discussed. Current shielding models of pellet ablation are reviewed, along with the problems concerning pellet deceleration, its injection speed, and deposition of ablated materials. The interaction of a pellet with its surrounding plasma and the effect on the ignition requirement and particle confinement time are outlined. A pellet source is described, and experiments are covered.

A80-44663 Absolute dissipative drift-wave instabilities in tokamaks. L. Chen, M. S. Chance, and C. Z. Cheng (Princeton University, Princeton, N.J.). *Nuclear Fusion*, vol. 20, July 1980, p. 901-905. 12 refs. Contract No. EY-76-C-02-3073.

Contrary to previous theoretical predictions, it is shown that the dissipative drift-wave instabilities are absolute in tokamak plasmas. The existence of unstable eigenmodes is shown to be associated with a new eigenmode branch induced by the finite toroidal coupling.

(Author)

A80-44664 Transport code simulations of lower hybrid heating in tokamaks. J. Ogden and S. Bernabei (Princeton University, Princeton, N.J.). *Nuclear Fusion*, vol. 20, July 1980, p. 906-912. 13 refs. Contract No. EY-76-C-02-3073.

A simple model of lower hybrid heating is included in the BALDUR 1-D tokamak transport code, in which wave energy is absorbed by the ions via linear mode conversion and by the electrons via linear Landau damping. A comparison is made with ATC data, and simulations of PLT carried out for various input RF power spectra are outlined.

V.T.

A80-44676 Wind energy planning - Development and application of a site selection method for wind energy conversion systems /WECS/. T. Otawa. International Journal of Energy Research, vol. 4, July-Sept. 1980, p. 283-306. 23 refs.

A80-44773 A 150 MW power generating gas turbine plant. I. S. Bodrov, A. P. Ogurtsov, and V. Ia. Reznichenko (Leningradskii Metallicheskii Zavod, Leningrad, USSR). (Teploenergetika, vol. 26, Nov. 1979, p. 11-17.) Thermal Engineering, vol. 26, Nov. 1979, p. 641-647. Translation.

The design and parameters of a 150-MW power generating gas turbine (GT) plant are described. The plant is designed according to a

simple cycle arrangement with the tandem configuration of a turbine group. The increasing of a turbine inlet gas temperature makes it possible to increase the capacity of the plant to 200 MW.

V.T.

A80-45054 Internally cooled cabled superconductors. I. M. O. Hoenig (MIT, Cambridge, Mass.). *Cryogenics*, vol. 22, July 1980, p. 373-389. 19 refs. Research supported by the U.S. Department of Energy.

A state of the art review and survey of work performed at the Massachusetts Institute of Technology in the area of internally cooled cabled superconductors (ICCS) is presented. Topics examined include original concepts, hollow concept, and heat transfer using supercritical helium. Attention is given to the ICCS conductor and coil design as well as experiments with niobium-titanium. M.E.P.

A80-45275 # Power extraction from deep ocean waves employing a novel wave energy device. D. Jones (Arrow Manufacturing Co., Columbus, Ohio), D. A. Guenther, and W. Chiou (Ohio State University, Columbus, Ohio). American Society of Mechanical Engineers, Energy Technology Conference and Exhibition, New Orleans, La., Feb. 3-7, 1980, Paper 80-Pet-29. 5 p. 20 refs. Members, \$1.50; nonmembers, \$3.00.

An investigative analysis is presented in which further verification of the Jones Wave Energy extracting system is discussed. The energy produced, based on the novel concept, has been shown to be significantly greater than in previously designed float devices. Full-scale testing was also initiated to illustrate the effects of the float on the wave front. (Author)

A80-45291 Nonlinear coupling of the slow wave structure with the lower-hybrid waves near the plasma surface. A. Fukuyama, T. Morishita, and Y. Furutani (Okayama University, Okayama, Japan). *Plasma Physics*, vol. 22, June 1980, p. 565-578. 14 refs.

A study is presented which investigates nonlinear coupling between the slow mode launched by a waveguide array and a plasma slab near the plasma surface as a problem of one-dimensional steady state wave propagation in an inhomogeneous plasma. A numerical analysis is carried out based on the nonlinear equation for an electric field with two different density profiles. The analysis is then compared with results analytically obtained from the model with a shifted linear density profile which globally accounts for the effect of the ponderomotive force.

M.E.P.

A80-45375 \* # Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines. W. Trela (Ford Motor Co., Dearborn, Mich.). U.S. Department of Energy, International Symposium on Automotive Propulsion Systems, 5th, Dearborn, Mich., Apr. 14-18, 1980, Paper. 25 p. Contract No. DEN3-00019.

The paper reviews the progress of the major technical tasks of the DOE/NASA/Ford program Evaluation of Ceramics for Stator Applications in Automotive Gas Turbine Engines: reliability prediction, stator fabrication, material characterization, and stator evaluation. A fast fracture reliability model was prepared for a one-piece ceramic stator. Periodic inspection results are presented.

V.T.

A80-45663 # The behavior of a closed-cycle gas turbine with time dependent operating conditions. K. Bammert (Hannover, Universität, Hanover, West Germany) and H. Poesentrup (Maschinenfabrik Augsburg-Nürnberg AG, Munich, West Germany). (American Society of Mechanical Engineers, Israel Joint Gas Turbine Conference and Exhibition, Haifa, Israel, July 9-11, 1979, Paper 79-GT/Isr-2.) ASME, Transactions, Journal of Engineering for Power, vol. 102, July 1980, p. 579-583.

The closed-cycle gas turbine can be applied in thermal power stations using fossil, nuclear or solar energy. Here the behavior of the closed-cycle gas turbine plant under time dependent operating conditions is particularly important. A theoretical model was developed which unlike previously applied methods also considers the transient processes in the heat exchanging units, the heat transfer,

between the working medium and the internally insulated hot-gas pipes, and the condition of the blading. For examination of the model, measurements were taken on a closed-cycle air turbine. The results of the calculation made for comparison with the test results show the reliability of the calculation model. There is conformity of the measured speeds of the turbo group and of the pressures, temperatures and mass flows of the cycle with the theoretical values until a new steady-state condition is reached.

(Author)

A80-45850 # The Tandem Mirror Fusion Test Facility. Energy and Technology Review, July 1980, p. 1-9.

The Tandem Mirror Fusion Test Facility (MFTF-B) proposed to take the place of the Mirror Fusion Test Facility (MFTF) under construction since 1978 and scheduled for completion in 1982 is presented. The tandem configuration, inspired by the success of the Tandem Mirror Experiment, is expected to represent an increase in confinement time from 10 msec to several seconds and in power from 1/30 to almost equal to breakeven over the original MFTF. while using essentially all of the equipment currently under construction. The tandem mirror cell planned would employ a combination of the simple mirror solenoid and the minimum-B single cell which counteracts the limitations of each cell alone, making possible high values of the power input/output ratio. A thermal barrier is proposed to create a potential difference between plasma at the center and plugs of the cell without requiring high neutral beam energy and magnetic fields. MFTF-B represents an expansion of the original systems, including the vacuum vessel, vacuum and cryogenic systems, magnet system, neutral beam source, microwave power system, and operating system. MFTF-B can be completed by 1984 and represents a significant advance in the physics and technology of mirror reactors. A.L.W.

A80-45851 Eigenvalue bounds for Hill's equation. D. Lortz (Max-Planck-Institut für Plasmaphysik, Garching, West Germany) and E. Rebhan (Düsseldorf, Universität, Düsseldorf, West Germany). Mathematical Methods in the Applied Sciences, vol. 2, no. 3, 1980, p. 288-302. 5 refs. EURATOM-sponsored research.

Consideration is given to the lower bounds of the lowest eigenvalue of a Sturm-Liouville eigenvalue problem for Hill's equation encountered in the theory for magnetohydrodynamic equilibria stability. By the introduction of Lp norms, lower bounds for the finite, nondegenerate lowest eigenvalue which depend only on this norm are derived for the cases p equals 1, 2 and infinity by the solution of a variational problem. Analytical expressions for the solution of the variational problem are presented which are shown to be monotonically increasing. Examples of the application of expressions for the lower bounds in the use of the energy principle in the determination of the stability of toroidally confined plasma equilibria and in the special case of Mathieu's equation are then presented.

A80-46158 Cathode sheaths in potassium seeded MHD combustion plasmas. A. Chandra, R. P. Dahiya, G. V. R. Raju, and R. G. Gupta (Indian Institute of Technology, New Delhi, India). Journal of Physics D - Applied Physics, vol. 13, July 14, 1980, p. 1211-1219. 13 refs. Research supported by the Council of Scientific and Industrial Research of India.

This communication presents a systematic study of cathode sheaths in seeded products of stoichiometric combustion of liquefied petroleum gas and oxygen. The effect of electrode temperature on thermal sheath thickness is investigated. The experimental values of the electrostatic sheath thickness developed over the cathode surface have a good qualitative agreement with the theoretically predicted values for different seeding ratios and the applied potentials between the electrodes. The breakdown potential is observed to decrease by increasing the cathode temperature. (Author)

A80-46599 # Matching of a radioisotopic thermoelectric generator and an energy accumulator (O soglasovaniiakh radioizotopnogo termoelektrogeneratora s nakopitelem energii). V. I. Isachenko,

Iu. G. Basin, Iu. A. Grits, and A. A. Simonov (Akademiia Nauk Gruzinskoi SSR, Fiziko-Tekhnicheskii Institut, Sukhumi, Georgian SSR). Tekhnicheskaia Elektrodinamika, vol. 3, May-June 1980, p. 90-95. In Russian.

The matching of a radioisotopic thermoelectric generator and an accumulator battery is discussed for a case involving a drift of the voltage-current characteristic of the generator. Advantages of parametric matching by means of a voltage converter with an input characteristic identical to the drift trajectory are shown.

V.L.

A80-46670 # CT-6 tokamak research. II - Experimental results. Acta Physica Sinica, vol. 29, June 1980, p. 764-777. 6 refs. In Chinese, with abstract in English.

The paper describes the phenomena observed and characteristic relations derived from experimental data obtained during more than 40,000 experimental discharges on CT-6 tokamak. These data are related to conditions for stable tokamak discharge, stages of toroidal discharge formation, impurity behavior, and plasma-wall interactions.

A80-47080 # Thermodynamic analysis of the helium cycles of gas turbine nuclear power plants (Termodinamicheskii analiz gelievykh tsiklov gazoturbinnykh atomnykh elektrostantsii). N. P. Panasiuk (Akademiia Nauk Ukrainskoi SSR, Institut Problem Mashinostroeniia, Kharkov, Ukrainian SSR). Problemy Mashinostroeniia, no. 7, 1978, p. 101-107. 5 refs. In Russian.

A method is proposed for determining thermodynamically optimum parameters of helium cycles in gas turbine nuclear power plants with allowance for internal losses and the actual state of the working medium. Thermodynamic parameters obtained by this method can be used as a first estimate of the efficiencies of various operation schemes, while the final determination of optimum operation variables must be based on a complex analysis of the thermodynamical characteristics of the cycle together with the characteristics of the heat exchangers and economic factors.

A80-47100 The case for fuel-cell-powered vehicles. J. B. McCormick (California, University, Los Alamos, N. Mex.) and J. R. Huff (U.S. Army, Electrical Power Laboratory, Fort Belvoir, Va.). Technology Review, vol. 82, Aug.-Sept. 1980, p. 54-65. 16 refs.

The use of fuel cells, which convert the energy of a chemical reaction between a fuel and an oxidant directly into electricity, as an energy source for future electric motor vehicles is discussed. The development of practical fuel cells for use in space systems is reviewed, and two fuel-cell-powered vehicles constructed and tested during the 1960s are indicated. The results of studies undertaken in 1977 and 1978 on the potential of a hypothetical hybrid vehicle powered by fuel cells and electric batteries are reported which found that the best near-term fuel would be coal-derived methanol and that fuel cell power would be technically and economically feasible by 1990 for city buses, highway buses and heavy trucks, delivery vans and consumer cars. Increases in fuel costs making fuel cell vehicles more economically attractive than predicted in 1978 are pointed out, and design changes which would reduce the costs and boost the power densities of fuel cells are indicated.

A.L.W.

A80-47135 Alternate synthesis of electrolyte matrix for molten carbonate fuel cells. R. H. Arendt and M. J. Curran (GE Research and Development Center, Schenectady, N.Y.). (Electrochemical Society, Meeting, 155th, Boston, Mass., May 6-11, 1979.) Electrochemical Society, Journal, vol. 127, Aug. 1980, p. 1660-1663. 8 refs. Contract No. DE-ACO3-77ET-11319.

An alternate process for the preparation of an electrolyte matrix composed of LaAlO2 crystallites for molten carbonate fuel cells is presented which does not involve the presence of the electrolyte or its precursors. The so-called chloride synthesis is based on the use of a fugitive molten ionic solvent, a mixture of alkali chlorides, to promote the formation of LiAlO2 from Al2O3.3H2O and excess LiOH.H2O at temperatures between 935 and 945 K. Preliminary experiments have shown product surface area to decrease with increasing reaction temperature, with a change in slope near the

binary chloride liquidus temperature attributed to the admixture of small sized, poorly crystalline gamma-Al2O3 to the predominantly LiAlO2 product. Increased LiOH.H2O excesses were found to have little effect on product surface areas. Products derived from original and recycled solvent mixtures were found to be composed mainly of beta-LiAlO2 crystallites of varying morphology and size which yielded matrix compacts with a broadened porosity distribution which could easily be converted to matrix-electrolyte composites.

A.L.W

A80-47136 Alternate fabrication process for molten carbonate fuel cell electrolyte structures. R. H. Arendt and M. J. Curran (GE Research and Development Center, Schenectady, N.Y.). (Electrochemical Society, Meeting, 155th, Boston, Mass., May 6-11, 1979.) Electrochemical Society, Journal, vol. 127, Aug. 1980, p. 1663-1666. Contract No. DE-AC03-77ET-11319.

A process is presented for the preparation of reinforced molten carbonate fuel cell electrolyte structures which does not involve a hot-pressing operation. This process is based on the use of an electrolyte-free LiAlO2 matrix material of predetermined, tailored characteristics. The matrix is fabricated into a 'blank' using conventional ceramic techniques. The 'blank' is subsequently infiltrated under controlled conditions with molten electrolyte. (Author)

A80-47143 Testing of sintered LiAlO2 structures in molten carbonate fuel cells. J. W. Sim, R. N. Singh, and K. Kinoshita (Argonne National Laboratory, Argonne, III.). Electrochemical Society, Journal, vol. 127, Aug. 1980, p. 1766-1768. 9 refs.

A80-47230 Form factor for certain types of toroidal solenoids. V. I. Koriavko and Iu. A. Litvinenko. (Zhurnal Tekhnicheskoi Fiziki, vol. 49, Nov. 1979, p. 2298-2303.) Soviet Physics - Technical Physics, vol. 24, Nov. 1979, p. 1279-1282. Translation.

The paper derives the relationship between the power requirement and the resulting field for toroidal solenoids with a helical winding. An expression is formulated for the form factor which is analogous to the Fabry coefficient for cylindrical solenoids; the optimum geometric parameters are computed for the helical winding of a 'force free' toroidal solenoid. The geometric parameters of toroidal solenoids can be selected from the curves presented here using the power requirement and the volume of the winding material.

A80-47415 On calculating gas turbine efficiency reduction under the influence of air cooling. E. N. Bogomolov. (Aviatsionnaia Tekhnika, vol. 22, no. 3, 1979, p. 14-22.) Soviet Aeronautics, vol. 22, no. 3, 1979, p. 10-16. 12 refs. Translation.

A method for determining the efficiency of a gas turbine with open air cooling is presented. The method is based on the assessment of the change in the available energy of the working fluid caused by the operation of the cooling system. The method is suitable in the engine design stage and makes it possible to analyze the cooling of individual turbine components and the losses associated with the cooling system.

B.J.

A80-47424 Comparative analysis of the basic combustion characteristics of some heavy hydrocarbon fuels in application to aircraft gas turbine engines. F. A. Khamidullin, O. V. Strogonov, and A. V. Talantov. (Aviationnaia Tekhnika, vol. 22, no. 3, 1979, p. 67-72.) Soviet Aeronautics, vol. 22, no. 3, 1979, p. 51-55. 11 refs. Translation.

A comparative analysis shows that the basic combustion characteristics of a homogeneous mixture of diesel fuel and air do not differ significantly from the combustion characteristics of the traditional aircraft fuels. Consequently, with suitable organization of the process in the chamber, the diesel fuel will burn with the same efficiency. However, attempts to use diesel fuels in the conventional gas turbine engine combustion chambers designed for the use of kerosene lead to low combustion efficiency and increased carbon formation, which is the primary obstacle to their use in jet engines.

This is explained by the deterioration of the mixture formation, which depends on the physical properties of the fuel.

B.J.

A80-47525 # Preliminary results from the shrouded wind-turbine pilot plant. O. Igra (Negev, University, Beersheba, Israel). Journal of Energy, vol. 4, July-Aug. 1980, p. 190-192. 9 refs. Research supported by the Ministry for Energy and Infrastructure of Israel and the U.S.-Israel Binational Science Foundation.

Performances obtained during the first three months of operation of a shrouded wind turbine generator pilot plant are reported. The apparatus consists of a horizontal-axis wind turbine of diameter 3 m surrounded by a 6-m in diameter shroud in the form of an annular wing with the suction side directed inward connected to an electric generator and a standard gearbox. Measurements of electrical power output as a function of wind speed reveal that at a speed of 5 m/sec, for which it was designed, the output is 0.66 kW, corresponding to an overall efficiency of 82.5% and an augmentation factor of two. Further increase in augmentation is expected from the employment of boundary layer control techniques and/or a ringshaped flap.

A.L.W.

A80-47600 # Experimental investigation of systems for diminishing the structural loads of large wind turbines (Experimentelle Untersuchung von Systemen zur Minderung von Strukturbelastungen grosser Windturbinen). S. F. Stiemer. Stuttgart, Universität, Dr.-Ing. Dissertation, 1979. 78 p. 30 refs. In German.

A new rotor concept, based on providing both swivel and flapping capability to the individual rotor blades, is proposed as a means of reducing the wind-shear and gravity forces on wind turbines. The effectiveness of this concept is demonstrated on the basis of a physical model. The influence of individual parameters is examined, and measurements aimed at verifying and improving a mathematical model are described.

V.P.

A80-47763 # Study of the insulating wall boundary layer in a Faraday MHD generator. R. R. Rankin, S. A. Self, and R. H. Eustis (Stanford University, Stanford, Calif.). AIAA Journal, vol. 18, Sept. 1980, p. 1094-1100. 16 refs. Contract No. EX-76-C-01-2341.

An experimental and analytical investigation of the insulating wall boundary layer in an operating MHD generator was undertaken. Velocity profiles were measured by a laser anemometer technique and the results compared with the finite difference solution of the momentum, energy, and electrical equations accounting for variable equilibrium properties. Both experimental and theoretical results showed a velocity overshoot near the wall for subsonic flow with an attendant increase in friction factor and Stanton number over that expected without MHD effects. The calculations were extended to larger size MHD generators; and for a subsonic pilot plant unit, an increase of the sidewall friction factor of over 150% was indicated with a 50% increase in Stanton number. Calculations for a supersonic generator showed that flow separation may occur on the sidewall because of the current pattern caused by the temperature overshoot common in supersonic boundary layers. (Author)

A80-48022 # Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler. A. J. Sistino (Argonne National Laboratory, Argonne, III.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-44. 10 p. 7 refs. Members, \$1.50; nonmembers, \$3.00. Research supported by the U.S. Department of Energy.

Two methods are used to calculate the temperature profile in the radiant boiler of an open-cycle MHD system. The first method, essentially a one-dimensional technique, assumes that the gas radiates to the immediate surrounding wall with the exception of the entrance and exit end walls. The emissivity and absorptivity of the gas is taken from the Hottel chart, which is based upon an assumed mean beam length, local temperature, and molecular local concentrations of CO2/H2O. A second method, the zone method, is used to perform the corresponding calculations, and the results of the two

methods are compared. For temperatures at the exit of the boiler, the results differ by 150 K. The effect on NO/x/ decomposition is given for the temperature profile determined by each of the two methods of calculating radiative heat transfer. (Author)

A80-48040 # Heat transfer as a diagnostic tool in the development of direct coal-fired MHD combustors. G. D. Roy (Tennessee, University, Tullahoma, Tenn.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-125. 7 p. 10 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. DE-AC01-79ET-10815.

Heat transfer from combustor walls was used as a diagnostic tool to optimize combustor configuration for direct coal-fired magneto-hydrodynamic (MHD) generators. Required oxidant velocities and residence times were obtained with recirculatory flow and turbulent mixing using a multiport oxidant injector in a vitiation heater-combustor. Peak heat flux values increased with increasing combustion efficiency, while overall heat losses were acceptable, resulting in good thermal efficiency and best operation of the coupled generator. A zone heat transfer model adequately predicts the radiant energy transfer to the combustor walls. The heat flux distribution in the MHD generator agrees well with a quasi one-dimensional model with chemical reaction, friction and heat transfer. (Author)

A80-48165 Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volumes 1, 2 & 3. Conference sponsored by AIAA, ACS, ANS, ASME, AICHE, SAE, and IEEE. New York, American Institute of Aeronautics and Astronautics, Inc., 1980. Vol. 1, 896 p., vol. 2, 864 p., vol. 3, 935 p. Price of three volumes, members, \$145.; nonmembers, \$165.

The conference focused on advanced power cycles for fusion; aircraft electrical power systems; aircraft, missile, and launch facility batteries; aerospace high voltage technology; NiCd space batteries; aerospace power system simulation; space photovoltaics, and solar arrays; fossil fuels. and fuel cells. Papers were presented on photocell heat engine solar power systems, power technology for fusion reactors, Comsat/Intelsat Ni-H battery technology, GaAs solar cells for space applications, Pioneer Venus multiprobe and orbiter solar array performance, lead-acid batteries for energy storage, the near-term hybrid vehicle, coal liquefaction and gasification, and synfuels from fusion.

A80-48173 \* # Progress in space power technology. J. P. Mullin, L. P. Randolph, and W. R. Hudson (NASA, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 83-88.

The National Aeronautics and Space Administration's Space Power Research and Technology Program has the objective of providing the technology base for future space power systems. The current technology program which consists of photovoltaic energy conversion, chemical energy conversion and storage, thermal-to-electric conversion, power systems management and distribution, and advanced energetics is discussed. In each area highlights, current programs, and near-term directions will be presented. (Author)

A80-48174 # Future space power - The D.O.D. perspective. T. Mahefkey (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 89-94. 6 refs.

The paper presents DOD space power studies which show a trend towards higher power levels in future missions. Military power systems in the 100 kW electrical capacity will be built by the year

2000 for new types of missions, while maintaining current technology in the 1-10 kW range. While NASA and COMSAT projects will provide high power capabilities, military requirements will be fulfilled by the development of new high-level, high-power density survivable space energy technology. Solar systems in the 100-250 kW range, with 25 W/lb densities, and nuclear reactors with energy densities in the 50 W/lb range or greater will be used in future missions.

A.T.

A80-48182 # The Federal Geothermal Energy Program. R. A. Black (U.S. Department of Energy, Office of Renewable Resources, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 151-155.

Geothermal energy can make a significant contribution to our domestic energy supply. The goal of the Federal Geothermal Energy Program is to provide the maximum practicable contribution from geothermal energy to our domestic energy supply. To achieve this end, the program includes resource assessment and reservoir confirmation activities to define and confirm high-temperature hydrothermal resources for electric power production, low-to-moderate hydrothermal temperature resources for a variety of direct heat applications and assessments of geopressured resources for methane production and thermal energy applications; research and technology activities include exploration technology, geochemical engineering, materials development, and well production and stimulation research; component development activities are directed at reducing the cost of drilling, well completion, and energy conversion equipment; technology demonstrations include design, construction, and operation of both pilot and commercial scale facilities to demonstrate new energy conversion equipment and processes.

(Author)

A80-48183 # Adapting geothermal energy to produce ethanol for automotive fuel. R. A. Stenzel, J. Yu, and E. H. Houle (Bechtel National, Inc., San Francisco, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 162-166. Contract No. DE-AC07-79ID-12050.

The paper describes a conceptual alcohol production facility which can convert wheat, sugar beets, and potatoes to 76 million liters/yr of anhydrous ethanol using flashed geothermal liquid as the primary energy source. Three levels of geothermal steam are extracted from the assumed 138 C fluid resource; the steam is used indirectly except for a small amount of cooking steam. Economic analyses show that alcohol production is very sensitive to the feed crop costs; reasonable returns on investment can be obtained with an alcohol price of less than \$0.53/liter. The cost of geothermal-derived steam is equivalent to about 8.5 mills/kJ.

A.T.

A80-48184 # Heat pumps in low temperature applications. J. G. Keller and R. C. Schmitt (EG & G Idaho, Inc., Idaho Falls, Idaho). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 167-169.

The paper describes water-to-air and water-to water heat pumps for use with domestic or thermally marginal geothermal water in low temperature applications. Pumps are available for the 10-32 C range, and can be custom designed for source temperatures above 32 C to bridge the gap between direct and indirect utilization methods. A new and novel diaphragm type heat pump for application with source temperatures down to 40 C which is competitive with existing absorption or refrigeration systems is discussed.

A.T.

A80-48185 # Open-cycle MHD generator channel development, R. Kessler (Avco Everett Research Laboratory, Inc., Everett,

Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 170-178. 14 refs. Research supported by the U.S. Department of Energy.

This paper describes the current status of MHD generator channel development, primarily as related to the requirements of open-cycle coal-burning MHD power generation systems. The major objectives which are important for the successful operation of channels in utility service are discussed. These include demonstration of acceptable channel lifetime, aerodynamic and electrical performance, scaling capability, and development of loading and control schemes. The paper reviews significant progress which has been made towards meeting goals in these areas. Critical design criteria and limitations on channel operating parameters which have evolved are described. Remaining technical uncertainties and future developmental needs are discussed.

(Author)

A80-48186 # Development of steam generator components for open-cycle MHD. T. R. Johnson, G. F. Berry, and M. Petrick (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 179-185. 12 refs. Research sponsored by the U.S. Department of Energy.

The paper presents experimental data and the status of design and operation of open-cycle MHD steam generating plants. The radiant boiler requires low cooling rates to permit the decomposition of NO; information is being developed on the emissivity of slag-laden combustion gases, and the effect of boundary layers and gas mixing on NO concentrations. The secondary combustion mixing zone should not impinge on hot metal surfaces because of corrosive nature of alternating oxidizing-reducing gases; the heat flux effects and corrosivity of liquid seed deposits and the removal of solid seed deposits are investigated. Metal alloys for steam heater tubes must operate at temperatures up to 880 K, and refractories are selected for lining the radiant boiler to reduce heat fluxes and protect boiler tubes from corrosion and erosion.

A.T.

A80-48187 # Component Development and Integration Facility - A description and status report. R. A. Carrington and J. M. Sherick (Montana Energy and MHD Research and Development Institute, Inc., Butte, Mont.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 186-191.

The paper describes the Component Development and Integration Facility (CDIF) for testing of coal-fired, open cycle MHD plant components. The facility coal preparation and injection system consisting of a predryer, dryer/pulverizer, and an injector is discussed along with combustion oxygen enriched air, dry seed material, fly-ash/dry seed, and quench systems. The data acquisition operation which will record operation parameters, pressures, levels, flows, conductivity, voltages, and current is examined; the power circuit which will conduct electricity generated in the MHD channel to the high voltage termination panels is depicted. Finally, the test program which will characterize each component and their interactions is abulated which includes testing of an ash-injected, oil-fired combustor using subsonic channel design and advanced power train testing to simulate the Engineering Test Facility (ETF).

A80-48221 # Condenser designs for binary power cycles. J. W. Michel and R. W. Murphy (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22. 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 449-454. Contract No. W-7405-eng-26.

The paper describes the development of improved condensers for geothermal binary power cycles. The work emphasized optimization of the design variables related to fluted surfaces on vertical tubes, and a comparison of the tube performance with available enhanced tubes for vertical or horizontal operation. Results were obtained for seven fluids including a hydrocarbon, fluoro-carbons, and ammonia condensing on 30 different tubes of different effective lengths and inclination. It was concluded that fluted tubes enhance the condensation coefficient by a factor of 6 over smooth tubes and by a factor of 2 over enhanced commercial tubes operating vertically or horizontally.

A.T.

A80-48222 # Simulation of mass transfer processes in geothermal power cycles with direct contact heat exchange. J. F. Knight and J. J. Perona (Tennessee, University, Knoxville, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 471-475.6 refs.

Computer models have been developed to predict heat and mass transport in direct contact preheaters, direct contact boilers, and surface condensers. These models are incorporated into a computer program which predicts isobutane concentration in the spent brine leaving the pre-heater, and the distributions of carbon dioxide and hydrogen sulfide between liquid and vapor phases throughout the power cycle. The effects of several process variables, such as isobutane/brine flow rate ratio and boiler pressure, are discussed.

(Author)

A80-48223 # U.S./U.S.S.R. joint MHD generator testing at the U-25 MHD pilot plant. B. F. Picologlou (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 476-481. 15 refs. Contract No. W-31-109-eng-38.

Joint generator tests performed at the U-25B MHD Facility and their relevance to MHD generator testing are discussed. These tests employed Soviet channel No. 2 and the U.S. superconducting magnet system. The MHD generator, achieving its design electrical power (1.2-1.4 MW), developed about 1.3 MW with potassium seeding and about 1.5 MW with cesium seeding. The generator operated stably at high power levels for 2.5 h under test conditions approaching those anticipated in commercial-size MHD plants with respect to Hall field, Hall parameter, current density, plasma conductivity, and wall heat flux. Data on the gas-dynamical, electrical, and thermal character sitics of the generator gathered during these tests are used to validate and improve analytical methods of predicting MHD generator performance. (Author)

A80-48224 # Development of the high temperature air heater for open cycle MHD. D. P. Saari, R. R. Smyth, C. L. Marksberry, and L. R. White (FluidDyne Engineering Corp., Minneapolis, Minn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 482-488. 9 refs. Contract No. DE-AC01-80ET-15602.

Development of the high temperature air heater (HTAH) is critically important to the future of MHD power generation. The development program includes subscale matrix and valve tests, materials evaluation, and computer modeling of full-scale systems. Technical feasibility of the directly-fired high temperature air heater concept has been demonstrated in the subscale test facilities, candidate air heater materials have been identified, and computer codes for evaluation of full-scale designs have been developed.

(Author)

A80-48225 # Near term commercialization of MHD power generation using coal/oil fuel. M. L. R. Murthy, J. C. Cutting, W. P.

Trzaskoma (Gilbert/Commonwealth, Reading, Pa.), and A. Manaker (Tennessee Valley Authority, Knoxville, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

of Aeronautics and Astronautics, Inc., 1980, p. 489-496. 9 refs. Research supported by the Tennessee Valley Authority.

An evaluation of the performance differences between the all-coal fired and coal/oil slurry burning MHD systems is presented. An MHD topping cycle of 50 MWe was integrated with a typical baseload stem plant of 800 MWe capacity for each fuel case. The two integrated plants, one using all-coal fuel and the other consuming coal/oil slurry in their MHD systems, were predicted to have a similar performance. The performance of each system was compared with the other process, plant differences were identified, and problem areas indicated.

A.T.

A80-48226 # Liquid-metal MHD for solar and coal - System and component status. E. S. Pierson, S. J. Grammel, D. Cohen, T. Frisardi (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

of Aeronautics and Astronautics, Inc., 1980, p. 505-510. 11 refs. Research supported by the U.S. Department of Energy.

The motivations for using two-phase-generator liquid-metal MHD (LMMHD) energy-conversion systems with solar collectors and cyclone-type coal combustors are given. The solar LMMHD studies presented focus on two collector temperatures - about 590 K (600 F) with an LMMHD Rankine cycle, an attractive temperature for near-term use, and about 1090 K (1500 F) with an LMMHD Brayton cycle, typical of higher-performance long-range uses. The coal LMMHD studies emphasize the development of a new system model and its application to performance and optimization analysis, and reactions of liquid copper with coal combustion products (gas, slag) and the use of the copper to control environmental impacts. Cogeneration applications and retrofits of existing central-station electric plants are particularly-attractive options of LMMHD with both solar and coal. High-efficiency high-power-density, and hightemperature LMMHD generator data are summarized, because they indicate that large, high-efficiency generators can be built. The status of the two-phase mixer and separator is discussed. (Author)

A80-48248 # The HTGR-GT closed-cycle gas turbine - A plant concept with inherent cogeneration /power plus heat production/ capability. C. F. McDonald (General Atomic Co., San Diego, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, New Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 667-675. 27 refs. Contract No. DE-AT03-76SF-70046.

The high-grade sensible heat rejection characteristic of the high-temperature gas-cooled reactor-gas turbine (HTGR-GT) plant is ideally suited to cogeneration. (In this paper, cogeneration broadly covers combined power and heat operation modes). Cogeneration in this nuclear closed-cycle plant could include (1) bottoming Rankine cycle, (2) hot water or process steam production, (3) desalination, and (4) urban and industrial district heating. This paper discusses the HTGR-GT plant thermodynamic cycles, design features, and potential applications for the cogeneration operation modes. This paper concludes that the HTGR-GT plant, which can potentially approach a 50% overall efficiency in a combined cycle mode, can significantly aid national energy goals, particularly resource conservation.

(Author)

A80-48249 # Over 50% efficiency achieved in gas turbine system using isothermal expansion. C. E. Jahnig. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 676-679. 8 refs.

Gas turbines are attractive because of low investment and low emissions, but the high cost of clean fuel makes it imperative to raise the efficiency. Most of the effort to increase efficiency of combustion turbines has been directed at raising inlet temperature; however, nechanical problems become severe. A different approach is to modify the cycle to more nearly approach the ideal Carnot efficiency, which corresponds to over 70% at 1370 K(2000 F.). To accomplish this a system is proposed using isothermal expansion over a first portion of the expansion by adding supplemental fuel which is burned during the expansion with the help of a catalyst. This is followed by a conventional adiabatic expansion. Overall efficiency of over 50% is projected based on 90% efficiencies for turbines and compressors.

A80-48250 # Power cycles analyses by generalized thermodynamic properties. A. V. Pradhan (W. L. Tanksley and Associates, Inc., Cleveland, Ohio) and V. H. Larson (Cleveland State University, Cleveland, Ohio): In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 680-685, 9 refs.

This paper points out the difficulties encountered in the selection of fluids for closed power cycles for various applications when the thermodynamic properties data for fluids is lacking. It presents the method of Generalized Properties and compares the thermodynamic excess functions obtained by the various correlations for a few fluids. The paper develops a procedure for the power cycles analyses based on the Generalized Properties of fluids. Cycles with some fluids for whom the thermodynamic data are available are analyzed using different correlations, and the results compared with those obtained by the conventional methods to establish accuracy of the method of cycle analysis by the Generalized Properties. It is shown that, for initial search purposes for new fluids, this method gives reasonable accuracy. Cycles with 36 different fluids for the various applications such as Geothermal, Bottoming, Topping and Fluidized Bed Coal Combustor System, are then analyzed and optimum fluids established for each application. (Author)

A80-48254 # High voltage power systems for military needs.

R. E. Corbett (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 715-719.

The objective of the High Voltage High Power (HVHP) Solar Power Systems Study is to provide the technology base for the development of a modular, 6-12 watt/lb, 10-50 kWe power module which meets the requirements of DOD space missions for the late 1980's. The requirement study indicates a high orbit emphasis with the orbits of greatest interest having significant natural radiation environments to be considered in both solar array and electronics design. Preliminary studies indicate that 6-12 watt/lb power systems are achievable using a combination of power source and energy storage technologies uniquely suited to the specific orbital applications reviewed.

A80-48255 # The 1980 technology status of the Dynamic Isotope Power System. G. L. Sorensen, R. E. Niggemann, M. W. Reck (Sundstrand Corp.; Sundstrand Advanced Technology Group, Rockford, III.), and W. D. Kenney (U.S. Department of Energy, Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 720-725. 5 refs.

The Dynamic Isotope Power System is intended for use in satellites in the 1980's. The current technology verification phase (TVP) is aimed at improving system efficiency by component development and furthering demonstration system reliability by endurance testing. This paper gives a system description and

considers spacecraft integration, the ground demonstration system, performance results and the TVP plan.

A80-48266 # Power production from geothermal brine with the rotary separator turbine. D. J. Cerini and L. G. Hays (Biphase Energy Systems, Inc., Santa Monica, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 788-797. 10 refs.

The use of the rotary separator turbine for geothermal power generation was investigated. A pilot scale unit was tested with a clean water/steam mixture and with geothermal brine/steam flows at East Mesa, California; Raft River, Idaho; and Roosevelt Hot Springs, Utah. The test turbine demonstrated 34% power addition to the output of a single stage flash steam system. Furthermore, the test unit provided clean steam for a steam turbine and high pressure brine for reinjection.

B.J.

A80-48267 # Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource. O. J. Demuth (EG & G Idaho, Inc., Idaho Falls, Idaho). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 798-803. Contract No. DE-AC07-76ID-01570.

Analysis of a number of geothermal binary-cycles were made with the objective of finding a cycle which can produce low-cost electrical energy from a moderately low-temperature geothermal resource. Cycles were screened which included isobutane, pentane, cis-2-butene, and several mixed-hydrocarbon working fluids. Dualand triple-boiling cycles were analyzed. Both shell-and-tube and direct-contact boilers, heaters, and condensers were assessed. A geothermal fluid (geofluid), typical of Raft River resource conditions was assumed, which has a temperature of 290 F and 52 parts per million dissolved nitrogen. Special emphasis in the analyses was directed toward investigation of several methods for keeping the loss of working fluid for the cycle at an acceptable level. It was concluded that for the Raft River geofluid, the direct-contact cycle has a potential for net geofluid utilization effectiveness values (watt-hr/lbm geofluid) equivalent to those of the shell-and-tube cvcle.

A80-48268 # Generalized performance predictions for energy conversion plants using geopressured geothermal fluids. J. P. Lamb, G. F. Polansky, and S. P. Bradley (Texas, University, Austin, Tex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 804-809. 12 refs.

A comparison of various energy conversion schemes has been made through use of Second-Law efficiencies based on brine availability evaluated between production and reinjection wellhead conditions. Included in the present comparisons are both simple plants involving a binary Rankine cycle or dual-flash steam production as well as more complex hybrid/compound plants which integrate brine energy conversion with conventional energy, sources. The latter types of conversion schemes are shown to yield higher levels of availability effectiveness than do simple conversion plants.

A80-48269 # Development of a 4 kW wind turbine generator. G. Bottrell and L. J. Sullivan (Structural Composites Industries, Inc., Azusa, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 810-814. Research supported by the U.S. Department of Energy.

76DP-03533.

The paper describes the design of a small wind energy conversion system (SWECS) that is to be rated at 4 kW and operated at a 10 mile/hour mean wind speed. The system will be used for remote residential applications. Results to date on the rotor, the electrical system, the nacelle, and the tower are presented.

A80-48270 # Interim status report on DOE prototype development SWECS. R. L. Moment and A. R. Trenka (Rockwell International Corp., Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 815-820. Contract No. DE-ACO4-

Development of several Small Wind Energy Conversion Systems (SWECS) underway for over two years as part of the Department of Energy's (DOE) Small Wind Systems program is described. Design and fabrication efforts are complete on prototype systems in three sizes: 1-2 kW for remote applications requiring high reliability, 8 kW and 40 kW, these latter two for intertie with utilities. Because the 40 kW systems were delivered much later than the 1-2 kW and 8 kW units, there is presently little test data collected from these units; consequently, this paper focuses on systems of the two smaller sizes. The paper discusses the design objectives for these development programs and offers a generic assessment of their progress. (Author)

A80-48273 # Wind energy for electric vehicle recharge. A. F. Sammells and A. A. Fejer (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 835-839. 18 refs.

The spatially diluted character of the kinetic energy content of wind makes it an attractive means of energy supply for electric vehicles intended for local traffic in suburban areas where individually owned windmills used for this purpose can be spaced at large enough distances from one another to avoid undesirable interference effects. These windmills would charge large stationary batteries whenever the wind intensity is sufficiently high, and the batteries would transfer their charge overnight to the small batteries carried by the vehicles. Such systems using wind generators of relatively small size (5 to 10 kW) are simple and rugged and should be able to operate over long periods between overhauls. Since it would be equipped with automatic controls, it could operate unattended and could bring about a significant near-term savings in the fuel required for transportation. This paper examines various aspects of systems of this type, leading to the conclusion that with the major components of the system already well-developed, this source of energy could be utilized in a cost-effective manner in most parts of this country.

A80-48279 # Development of molten carbonate fuel cells for power generation. K. W. Browall and F. N. Mazandarany (General Electric Co., Schenectady, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 870-874. Research supported by Genéral Electric Co.; Contract No. DE-AC03-77ET-11319.

The paper examines a program to develop molten carbonate fuel cells for utility power generation. High initial single cell performance has been achieved with high utilization (70%) of fuels typical of low-BTU coal gasification products. Achievements include the advancement and scale-up of single cell designs, the development of alternate synthesis and fabrication procedures for key cell components, and an understanding of cell hardware corrosion mechanisms. In addition, the first short-term tests of a fuel cell linked to an actual coal gasifier have been completed. An overview of the strengths and challenges of coal-fired molten carbonate fuel cell systems is also presented. (Author)

A80-48281 # Development of a high temperature solid electrolyte fuel cell. Y. Ohno, S. Nagata, and H. Sato (Ministry of International Trade and Industry, Electrotechnical Laboratory, Sakura, Ibaraki, Japan). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 881-885. 6 refs.

A high temperature solid electrolyte fuel cell made of oxides has been demonstrated in the laboratory. The optimum materials for the electrodes have not yet been defined, but a series of perovskite-type lanthanum cobalt oxides shows suitable properties for an air electrode of the fuel cell. The plasma flame spray process (PFSP) is the most suitable method to fabricate the complex structure of interconnected fuel cells. A multi-cell (6 cells) stack, fabricated by PFSP on a porous alumina tube, can operate at a maximum current density of 700 mA/sq cm at 1000 C. (Author)

A80-48282 # Improved alkaline hydrogen/air fuel cells for transportation applications. J. McBreen, G. Kissel, K. V. Kordesch, F. Kulesa, E. J. Taylor, E. Gannon, and S. Srinivasan (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics and Astronautics and Astronautics and Astronautics and Astronautics.

and Astronautics, Inc., 1980, p. 886-891. 12 refs. Research sponsored by the U.S. Department of Energy.

Alkaline air electrodes have been evaluated in alkaline hydrogen/air fuel cells. In initial tests with 289 sq cm electrodes, power densities of 100 mW/sq cm were obtained at 0.65 V. This compares with power densities of 27 mW/sq cm obtained by Kordesch in his vehicle fuel cell in the late sixties. Further improvements in the air electrode flow field yielded power densities of 126 mW/sq cm at 0.65 V at an operating temperature of 70 C. At 30 C, nearly 60% of this power could be obtained at 0.65 V. The 289 sq cm cells were units in a 16-cell 0.5 kW module. This module yielded similar power densities, and its power/weight and power/volume are sufficiently attractive for it to be considered as a building block for a fuel cell power plant in a fuel cell/battery hybrid vehicle. (Author)

A80-48283 # Improvement in stacking structures of fuel cells. H. Kawana, T. Kahara, K. Tamura, and T. Horiba (Hitachi, Ltd., Hitachi Research Laboratory, Hitachi, Ibaraki, Japan). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 892-894.

New cell stacking structures, U-shaped type and spiral types, have been developed. The structures feature light weight, small size, and internal electric connection. Power densities of 64 W/kg and 93 W/l for U-shaped structures, 77 W/kg and 98 W/l for three-roomed spiral stacks, and 86 W/kg and 139 W/l for four-roomed spiral stacks have been obtained. The new cell stacking structures are applicable not only to hydrogen-oxygen fuel cells but to other types of low-temperature fuel cells as well.

V.L.

A80-48284 \* # The kinetics of the O2/CO2 reaction in molten carbonate - Reaction orders for O2 and CO2 on NiO. J. Winnick (Georgia Institute of Technology, Altanta, Ga.) and P. N. Ross (California, University, Lawrence Berkeley Laboratory, Berkeley, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 895-899. 10 refs. Grant No. NsG-2193; Contract No. W-7405-eng-48.

The kinetics of the O2/CO2 reaction in molten carbonate is investigated using paste electrolytes and nickel sinter electrodes. A two-step approach to the determination of reaction orders is employed. First, exchange currents at various P(CO2) and P(O2)

(Author)

were measured using the low polarization method. Second, alpha(+) and alpha(-) values were obtained from the slope of the Allen-Hickling plot for current densities low enough so that concentration polarization within the electrode can be neglected. The reaction orders are + 1/4 in CO2 and + 5/8 in O2 in the cathodic direction, and · 3/4 in CO2 and + 1/8 in O2 in the anodic direction.

A80-48285 # Municipal solid waste and district heating - A case study. P. F. Donnelly (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 900-903.

The feasibility of energy recovery from municipal solid waste is examined with reference to the Recycle Energy System project now being implemented in Akron, Ohio. The system designed to burn 1000 tons of solid waste a day, consists of (1) a solid waste shredding facility, (2) three industrial spreader-stokers and boilers capable of using shredded commercial and residential solid waste as fuel, and (3) the existing and new steam distribution lines. The project financing, major problems, and current status are discussed.

V.L.

A80-48305 # RTG power source for the International Solar Polar Mission. R. D. Cockfield, R. F. Hartman, and C. E. Kelly (General Electric Co., Philadelphia, Pa.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1043-1046.

The design details of the radioisotope thermoelectric generator that will power the spacecraft for the International Solar Polar Mission are presented. The radioisotope heat source and the converter assembly are described. RTG performance is discussed with reference to air operation, vacuum operations, fuel decay, changes in thermoelectric properties, and insulation effects.

B.J.

A80-48314 # Raft River 5-MW/e/ geothermal pilot plant. R. R. Stiger (EG & G Idaho, Inc., Idaho Falls, Idaho). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1120-1123.

The Idaho National Engineering Laboratory geothermal programs have been geared to utilize moderate temperature hydrothermal resources (say 280 to 350 F). An outgrowth of this work has been the design of a 5-MW(e) binary cycle pilot plant which is being built in the Raft River valley in Idaho. This plant will utilize state-of-the-art components, but will employ a dual boiling power cycle using isobutane as the working fluid. It is designed to take maximum advantage of the low average seasonal temperatures and will contain sufficient instrumentation and data acquisition equipment to obtain accurate performance data. In addition, some of the large heat exchangers will contain special instrumentation to obtain details of their performance. (Author)

A80-48316 # Hawaii Geothermal Project 'A' wellhead generator feasibility project. H. Rogers, Jr. (Rogers Engineering Co., Inc., San Francisco, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1132, 1133.

A80-48317 # The challenge of financing geothermal development. P. Rodzianko (Geothermal Energy Corp., New York, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1134-1137.

A80-48318 # Feasibility studies of spoiler and aileron control systems for large horizontal-axis wind turbines. W. H. Wentz, Jr., M. H. Snyder (Wichita State University, Wichita, Kan.), and J. T. Calhoun. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1138-1142. 5 refs.

A80-48320 # Turbulence as experienced by a moving rotor of a wind turbine. J. R. Connell (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1149-1153.

A80-48321 # Implications of the effects of wind characteristics on the operation of large wind turbines. A. H. Miller (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980. p. 1154-1158.

The Wind Characteristics Program Element of the DOE Wind Systems Branch is examined. Three subtasks are considered: wind energy prospecting; wind characteristics for design, performance evaluation, and operations; and site evaluation. Attention is given to how wind characteristics affect the overall performance of large wind turbines. The first simulation of turbine output lends support to the potential need for site-specific strategies to optimize the annual output of a turbine.

B.J.

A80-48322 # The MOD-2 wind turbine. R. A. Axell and P. W. Helms (Boeing Engineering and Construction Co., Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1159-1163.

The MOD-2 is a 300-foot, 2.5-MW wind turbine system under development for the Department of Energy. This paper gives a description of the conceptual and preliminary design, the current status of the program, the plans for performance evaluation, and the outlook for its future commercial application.

B.J.

A80-48347 # Review of mini-OTEC performance. L. C. Trimble and W. L. Owens (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1331-1338. 6 refs.

This paper describes some of the results from the first at-sea Ocean Thermal Energy Conversion (OTEC) powerplant. The powerplant was mounted on a barge located approximately 1.5 miles off Keahole Point on the Kona Coast of Hawaii. Ammonia was employed as the working fluid in a closed-cycle (Rankine) powerplant which produced approximately 50 kWe of gross electrical power for an average seawater temperature difference of 38 F. Parasitic pumping power requirements for seawater and ammonia resulted in a net electrical power of approximately 15 kWe. Cold seawater was drawn from a depth of approximately 2200 ft through a 2-ft-diameter polyethylene pipe which formed a part of the single-point tension leg mooring system. The first net, closed-cycle, at-sea OTEC power was produced on 2 August 1979; plant operation concluded on 15 November 1979. (Author)

A80-48348 # Design of 40-MW grazing and moored OTEC pilot/demonstration plants. D. Richards, J. F. George (Johns Hopkins University, Laurel, Md.), and J. S. Seward (Seward Associates, Washington, D.C.). In: Energy to the 21st century;

Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1339-1346. 14 refs. Research sponsored by the U.S. Department of Energy.

Designs are presented and discussed for a plantship that cruises the tropical oceans, where the electrical energy generated by ocean thermal energy conversion (OTEC) is used to produce ammonia, replacing natural gas used in ammonia manufacture; and for a moored OTEC plant from which the electrical power is transmitted by undersea cable to an offshore island (Hawaii, Puerto Rico). Both designs use the same OTEC electric generating plants, sea water pumping systems, cold water pipe, and barge-type hull configuration developed from a similar to earlier designs. The OTEC power generating plants and the alternative usage equipment and plant processes are described, together with the integration and operational aspects of an ocean platform installation. The estimated performance, at the annual average temperature difference available, is 33.8 MW delivered onshore at Puerto Rico and 42.5 MW to product process on the cruising plantship. Acquisition and deployment costs are estimated at \$171 million for the moored plant and \$144 million for the cruising plantship in 1980 dollars. These costs assume all heat exchangers are the folded-tube design and do not include general contractor profit or contingencies. (Author)

A80-48349 # Projected costs, for electricity and products from OTEC facilities and plantships. G. L. Dugger, R. W. Henderson, E. J. Francis, and W. H. Avery (Johns Hopkins University, Laurel, Md.). In: Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1347-1354. 17 refs.

This paper addresses ammonia, liquid hydrogen, methanol, and liquid methane, which could be sold as fuels or chemicals or used as hydrogen sources for onshore fuel-cell power systems. Estimated costs of their production on 325-MWe ocean thermal energy conversion (OTEC) plantships, and their delivery to U.S. ports and inland sites are presented. The most promising product is ammonia, first for use in fertilizers and the chemical industry, and later as the least costly carrier of hydrogen for use in fuel cells. Estimated costs of delivering OTEC electricity by undersea cables from moored offshore plants to U.S. islands and Gulf Coast states are compared with costs of electricity from OTEC ammonia and from coal and nuclear power. Commercial viability for both OTEC approaches by the 1990-93 period is indicated. The potentials for private costsharing in the initial 40-MW demonstration facilities and plantships also are discussed. (Author)

A80-48350 # The commercial application of an OTEC Jacket /tower/ design. R. A. Hindle and P. B. Pribis (General Electric Co., Installation and Service Engineering Business Div., Schenectady, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1355-1359. 8 refs.

The OTEC Jacket concept is reviewed, with attention given to the general development program and the analyses used to show that the concept results in a plant that eliminates many high-risk items and is still competitive with conventional power generation schemes. Particular emphasis is placed on the heat exchangers, the working fluid, general optimization considerations, and how these relate to the basic plant support platform.

B.J.

A80-48351 # Material evaluation and testing program for OTEC riser cable. C. A. Pieroni, K. P. Roberts (Simplex Wire and Cable Co., Portsmouth, N.H.), T. F. Garrity, R. Eaton (U.S. Department of Energy, Div. of Solar Technology, Washington, D.C.), and T. C. Dalton (Gibbs and Cox, Inc., Arlington, Va.). In: Energy to

the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1360-1366. 14 refs.

This paper describes the test program for the final prototype riser cable development performance criteria of the 40 MW Ocean Thermal Energy Conversion (OTEC) pilot plant. The testing program will focus on two cable designs; a prototype cross-linked polyethylene (XLPE) cable and a self-contained oil filled (SCOF) laminated paper cable. Both cables are rated for 100 MW at 138 kV, but for the purpose of pilot plant demonstration they will be used at 40 MW at 138 kV. The test program involves the testing of cable components, the testing of model cables and the testing of full scale prototype cables. The component and model tests focus on three components seen as critical to the life of the cable: the hermetic sheath, the external armor, and the dielectric. The testing of full scale prototype cables will concurrently measure the cable's basic mechanical and electrical properties. (Author)

A80-48352 # Further analysis of a novel wave energy device. W. Chiou (ACF Industries, Inc., St. Charles, Mo.), D. A. Guenther (Ohio State University, Columbus, Ohio), and D. Jones (Arrow Manufacturing Co.; Ohio State University, Columbus, Ohio). In: Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1367-1374. 13 refs.

The paper presents a theoretical review of the Jones Wave Energy extracting system. The different analyses presented compare the approaches and assumptions used in each analytical development. Included are comments on the large body assumption and the importance of the radiation and scattering problem analogy. Modifications of the original design wherein power is extracted from both the 'up' and 'down' stroke illustrates that the ratio of the float power to the incident wave power per unit crest width exceeds other float devices by an order of magnitude. Experimental results from wave tank investigations and small lake prototypes have confirmed the energy potential of this system. The power produced from the experimental tests prove the increased amount of energy obtainable from the system over other types of floatation devices. In summary, the results presented in this work relative to the Jones Wave Energy Device show the potential of this system as a viable source of significant energy.

A80-48358 # Overview of high efficiency power cycles for fusion. A. Hertzberg (Washington, University, Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1406-1411. 14 refs.

Fusion power plant systems have a large circulating power fraction and are thus particularly sensitive to component efficiency. The component that converts the energy of fusion electrons to electricity plays a critical role. It is shown that, in the near term, neutron-to-electric conversion efficiencies of 45% can be considered. Systems with efficiencies approaching 70% appear feasible with the development of alternative high-temperature blankets currently being studied. The development of such high efficiency systems could also increase the efficiency of production of synthetic fuels from fusion energy and thereby increase the application options available for fusion.

B.J.

A80-48359 # Advanced power technology for fusion reactors. R. T. Taussig, J. F. Zumdieck, H. J. Willenberg, T. S. Vaidyanathan (Mathematical Sciences Northwest, Inc., Bellevue, Wash.), and J. R. Powell (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1412-1416. Research supported by the Electric Power Research Institute.

This paper assesses the technological and economic feasibility of achieving net electric power from a near-term fusion device by using high efficiency energy conversion technology. A variety of energy conversion/reactor blanket schemes have been considered and the best one, an argon topping cycle, steam bottoming cycle coupled to a zirconium oxide-based high temperature blanket, has been selected for conceptual design. The conceptual design integrates the blanket and power conversion system with all of the other major reactor subsystems such as the plasma heaters, vacuum vessel, magnets, fuel supply, tritium recovery, etc., using ETF parameters as the design base. Initial results for this conceptual design are presented here and indicate a thermal conversion efficiency of 58 percent. The advanced power technology proposed here could be introduced for testing on the ETF device in several stages to demonstrate its performance. A parallel technology development program in high temperature blanket materials and in advanced power conversion machinery (i.e., the energy exchanger) would be required to advance the power conversion system to its peak performance capabilities.

A80-48360 # Blanket options for high-efficiency fusion power. J. L. Usher, O. W. Lazareth, J. A. Fillo, F. L. Horn, and J. R. Powell (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1417-1422. 7 refs. Research sponsored by the Electric Power Research Institute.

The efficiencies of blankets for fusion reactors are usually in the range of 30 to 40%, limited by the operating temperatures (500 C) of conventional structural materials such as stainless steels. In this project 'two-zone' blankets are proposed; these blankets consist of a low-temperature shell surrounding a high-temperature interior zone. A survey of nucleonics and thermal hydraulic parameters has led to a reference blanket design consisting of a water-cooled stainless steel shell around a BeO, ZrO2 interior (cooled by argon) utilizing Li2O for tritium breeding. In this design, approximately 60% of the fusion energy is deposited in the high-temperature interior. The maximum argon temperature is 2230 C leading to an overall efficiency estimate of 55 to 60% for this reference case. (Author)

A80-48361 # Direct energy conversion for fusion power. G. H. Miley (Illinois, University, Urbana, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1423-1429. 27 refs.

The potential importance of direct energy conversion to the long-term development of fusion power is discussed with stress on the possibility of alleviating waste heat problems. This is envisioned to be crucial for any central power station in the 21st century. Two approaches, direct collection and magnetic expansion, are reviewed. While other techniques may be possible, none have received sufficient study to allow evaluation. Due to the intimate connection between the type of fusion fuel, the confinement scheme, and the energy conversion technique, all three elements must be optimized simultaneously for high overall efficiency. (Author)

A80-48386 # Demonstration of heat to electrical energy conversion with a ferroelectric material. R. B. Olsen (Power Conversion Technology, Inc., San Diego, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1586-1591. 11 refs.

The conversion of heat to electricity by means of the pyroelectric effect is demonstrated here. The basic thermal-electrical cycle is described. The production of 100 millijoule of electrical energy per cubic centimeter of ferroelectric material (PZST) per thermal cycle (with a temperature span of 20 C) has been observed. This observation is discussed with respect to regenerative heat engine thermal cycles which may provide high thermal to electric conversion efficiency (greater than 10%).

(Author)

A80-48387 \* # Electric energy production by particle thermionic-thermoelectric power generators. P. E. Oettinger (Thermo Electron Corp., Waltham, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1592-1594. 11 refs. Contract No. JPL-955009.

Thermionic-thermoelectric power generators, composed of a thin layer of porous, low work function material separating a heated emitter electrode and a cooler collector electrode, have extremely large Seebeck coefficients of over 2 mV/K and can provide significant output power. Preliminary experiments with 20-micron thick (Ba Sr Ca)O coatings, limited by evaporative loss to temperatures below 1400 K, have yielded short circuit current densities of 500 mA/sq cm and power densities of 60 mW/sq cm. Substantially more output is expected with cesium-coated refractory oxide particle coatings operating at higher temperatures. Practical generators will have thermal-to-electrical efficiencies of 10 to 20%. Further increases can be gained by cascading these high-temperature devices with lower temperature conventional thermoelectric generators. (Author)

A80-48390 # Analysis of the application of thermogalvanic cells to the conversion of low grade heat to electricity. H. L. Chum, R. F. Fahlsing, and T. S. Jayadev (Solar Energy Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1603-1609. 20 refs.

Aqueous thermogalvanic cells, the solution analogs of solid-state thermoelectric devices, are compared for power generation. Measurements on the copper/copper formate/copper system yield thermoelectric powers of 1.25-1.9 mV/degree, which are higher than those exhibited by other copper systems. In these solutions three copper formate complexes are present. Practical cells were built and tested. The power output is largely limited by cell resistance, though mass and charge transfer contribute to the observed overvoltages. The coupling of this thermogalvanic system with an electrochemical photovoltaic effect (a photothermogalvanic cell) is briefly described. (Author)

A80-48391 # Thermoelectric properties of bismuth-antimony thin films. J. Treffny (Colorado School of Mines, Golden, Colo.) and T. S. Jayadev (Solar Energy Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1610-1612.

Preliminary experimental data on the properties of bismuthantimony thin films are examined. The Seebeck coefficients of a series of three bismuth-rich films are displayed as a function of temperature in the range -20 to 100 C; and a plot of electrical conductivity versus temperature in the -20 to 100 C range is presented. The preliminary data indicate that thin films of bismuthantimony, prepared by the very simple means of thermal evaporation onto plastic substrates, are quite interesting from the point of view of inexpensive thermoelectric generator development.

A80-48407 # Analysis and design of free-piston Stirling engines - Thermodynamics and dynamics. R. Vincent, W. Rifkin, and G. Benson (ERG, Inc., Oakland, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conver-

sion Engineering Conference, Seattle, Wash., August 18-22, 1980.
Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1686-1695. 8 refs.

A design procedure applicable to kinematic as well as free-piston engines is presented which minimizes the computer costs and time required to design and optimize an engine. The first design step assesses major engine parameters with the help of an expression relating ideal engine power output to displacer swept volume, mean pressure ratio, and operating frequency. This expression leads to evaluation of design options using computer codes, which includes consideration of isothermal versus adiabatic working chambers. After optimization of the engine at its full load design point, part load operation is analyzed. Thermodynamic and dynamic results presented apply to a 23 kW solar powered engine with linear alternators, designed to operate at fixed frequency and voltage over the full load range without alternator field control.

A80-48408 # Harmonic analysis of Stirling engine thermodynamics. J. S. Rauch (Mechanical Technology, Inc., Latham, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1696-1700. 6 refs.

The present status of the Harmonic Stirling Cycle Analysis Code, designed to provide quick and reasonably accurate solutions to Stirling engine thermodynamic performance, is reviewed. Analytical solutions to the governing equations are presented, and the physical significance of the equations is shown graphically with vector and phasor diagrams. Current data suggest that the code predicts engine performance with an error less than 15%, without any empirical factors.

V.L.

A80-48410 # Performance loss due to transient heat transfer in the cylinders of Stirling engines. K. Lee (Foster Miller Associates, Inc., Waltham, Mass.), J. L. Smith, Jr. (MIT, Cambridge, Mass.), and H. B. Faulkner. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1706-1710. 7 refs.

A80-48411 # An algorithm for the preliminary design of Stirling engine heaters. G. T. Reader and D. Taylor (Royal Naval Engineering College, Plymouth, England). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1711-1715. 11 refs.

An algorithm is described which enables the basic dimensions of a Stirling engine heater to be calculated. The algorithm is made up of a number of self-contained calculation sequences (modules) which may be individually updated or used in whatever manner the analyst or designer requires to yield the desired data. In this paper the algorithm is used to determine the most cost effective heater design within the constraints of a pre-specified stress level, gas volume, end gas temperature and pressure drop. The algorithm could be applied with minor adjustments to the design of Stirling engine coolers and regenerators, and may be used for initial design optimizations.

(Author)

A80-48421 \* # Collector temperature effects on the performance of advanced thermionic converters and nuclear electric propulsion systems. R. S. Dick, J. McVey, E. J. Britt, and G. O. Fitzpatrick (Rasor Associates, Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fitteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3 New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1766-1772. 8 refs. Contract No. JPL-955033.

The specific weight of a thermionic nuclear electric propulsion (NEP) system depends on the collector temperature because of changes in power density, efficiency and the temperature of heat. rejection. Increasing the collector temperature above the value for maximum converter performance decreases both the efficiency and the power density of the converters, but the specific weight of the total system is decreased because of the reduction in radiator weight due to the increased heat rejection temperature. The effect of collector temperature on the performance of thermionic converters was investigated. The behavior of conventional ignited mode converters as well as advanced converters with lower collector work functions; the specific mass of an 'uninsulated' NEP system design was then evaluated as a function of collector temperature. The uninsulated design uses the electrical resistance of the heat pipes between the converters and the reactor to provide electrical insolation, eliminating the need for ceramic insulators at emitter temperature and providing other design advantages. The results indicate that an optimum collector temperature, which minimizes system weight, exists at a temperature above the optimum temperature for converter performance.

A80-48422 # Design study of a coal-fired thermionic /THX/-topped power plant. R. S. Dick, Jr. (Rasor Associates, Inc., Sunnyvale, Calif.), B. M. Banda (Bechtel National, Inc., San Francisco, Calif.), and J. W. Starr (Foster Wheeler Development Corp., Livingston, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1775-1782. 7 refs. Contract No. DE-AC02-76ET-11283.

This study uses innovative furnace design approaches, based on conventional furnace building techniques and new materials to design a furnace which better matches thermionic capabilities. A currently-available supercritical steam cycle is used for the bottoming plant. This study is performed using the Energy Conversion Alternatives Study (ECAS) ground rules and reporting format to enhance comparability with ECAS results. Operating parameters and performance of this new system are presented, along with capital costs and cost-of-electricity for current proven technology and future technology. The study shows that furnace design, heat exchanger design, and furnace-thermionic match have a significant impact on thermionic steam electric power plant performance and economic competitiveness. (Author)

A80-48423 # Thermionic topping of combined cycle powerplants and cogeneration applications. G. Miskolczy, C. C. Wang (Thermo Electron Corp., Waltham, Mass.), A. E. Margulies, and L. J. Fusegni (Stone and Webster Engineering Corp., Boston, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1783-1787. 6 refs. Contract No. DE-AC02-76ET-11291.

Thermionic energy converters operate at sufficiently high temperatures (typically, 1600 to 1800 K) to offer attractive topping options for conventional fossil-fired steam plants operating at lower temperatures (around 800 K) and for combined cycle plants with the gas turbine operating at an intermediate inlet temperature of approximately 1300 K. A flame-fired thermionic converter has demonstrated over 5000 hours of stable operation at an average emitter temperature of about 1630 K. At this operating temperature, the power density was 2.2 W/sq cm. (Author)

A80-48424 # Analysis of a heat-activated Stirling heat pump. T. Finkelstein (TCA Stirling Engine Research and Development Co., Beverly Hills, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 1788-1796. 6 refs.

The system analyzed utilizes a thermal energy input to elevate heat to a higher temperature level for refrigeration or heat pumping. The only two moving parts are two double-acting free piston assemblies which are maintained in oscillation by the applied heat. The working fluid is contained in a hermetically sealed enclosure. There are four simultaneous split Stirling cycles, each with three temperature levels and two expansion spaces, combined by the principle of balanced compounding. The dynamic equations of motion for the two reciprocators, as well as the thermodynamic equations for the four cyclic processes, are derived from first principles. They are solved simultaneously to obtain the oscillatory modes and frequency. (Author)

A80-48425 # Development of a diaphragm Stirling engine heat-actuated heat pump. R. A. Ackermann and T. J. Marusak (Mechanical Technology, Inc., Latham, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. New York, American Institute of Volume 3. Aeronautics and Astronautics, Inc., 1980, p. 1797-1801.

A new concept for a Stirling engine heat-actuated heat pump (HAHP) is presented. This concept is based on the use of a metallic diaphragm that has the potential for both simplifying operation and reducing cost as compared to more conventional Stirling engine HAHP designs. A development program is in progress to assess the full potential of this system. The program is intended to develop a breadboard system of the power module (combustor/Stirling engine/ diaphragms/compressor/controls) and fabricate and life-test several diaphragm geometries. The goal is to demonstrate the cost effectiveness of this new approach as well as the potential for diaphragms to exceed lives of 10 billion cycles without degradation or failure. B.J.

A80-48434 # Thermoelectricity - Phase diagrams and imperfection structures. II. D. Tuomi (Borg-Warner Corp., Roy C. Ingersoll Research Center, Des Plaines, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1853-1861. 58 refs.

A review is given of the contrasting behaviors of the three systems which have been reduced to commercial practice; the Ge-Si, PbTe, and (Bi,Sb)2(Te,Se)3 alloys. Progress depends upon recognizing the role of solid state chemistry in the simultaneous optimization of electron and phonon transport properties to ultimate performance

A80-48435 # Universal thermoelectric design curves, R. J. Buist (Marlow Industries, Inc., Garland, Tex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1862-1865.

A method has been introduced which enables users of thermoelectric heat pumps to specify or analyze any single-stage cooling application. This method was derived through computer analysis of temperature dependent thermoelectric theory applied to a generalized thermoelectric heat pump. Design parameters for the cooling mode normalized to their respective 'maximum cooling' values were relatively invariant as a function of base temperature. This introduced a set of universal design curves applicable over a base temperature range of -125 C to +125 C. This method has been expanded to include the performance of a heat pump in the reverse, or heating mode of operation. The same design parameters are used with the same normalization constants derived from the maximum cooling condition. Although inclusion of the heating mode quadrant to the universal design curves introduces complications, it affords a more complete understanding and characterization of a thermoelectric heat pump.

A80-48436 # Thermoelectric OTEC - An update. D. K. Benson, M. S. Bohn, J. Kowalik, and T. S. Jayadev (Solar Energy

Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1873-1877. 9 refs.

This paper describes analyses of thermoelectric ocean thermal energy conversion (TE-OTEC) system designs. A parametric model has been developed to predict the performance and capital cost of the TE-OTEC power system. This model was used to examine each design option and to minimize the capital cost per unit net electrical power output. Several design features such as heat transfer enhancement, and the use of the thermoelectric generators were found to be particularly advantageous. The optimized TE-OTEC design appears to be economically competitive with closed cycle ammonia OTEC designs and to be insensitive to the cost of the thermoelectric materials required.

A80-48448 # HYFIRE - Fusion-high temperature electrolysis system. J. A. Fillo, J. R. Powell, M. Steinberg, R. Benenati, V.-D. Dang. F. Horn, H. Isaacs, O. Lazareth, H. Makowitz, and J. Usher (Brookhaven National Laboratory, Upton, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1938-1942. 5 refs. Research sponsored by the U.S. Department of Energy.

HYFIRE is the comprehensive conceptual design study of a commercial tokamak reactor, high-temperature electrolysis system. Particular emphasis is placed on the adaptability of the STARFIRE power reactor to a synfuel application. The HYFIRE blanket must perform three functions: (1) provide high-temperature (about 1400 C) process steam at moderate pressures (10-30 atm) to the high-temperature electrolysis (HTE) units, (2) provide hightemperature (700-800 C) heat to a thermal power cycle for the generation of electricity to the HTE units, and (3) breed enough tritium to sustain the D-T fuel cycle. B.J.

Design characteristics and test results of the United Stirling P40 engine. C. Bratt (United Stirling /Sweden/, Malmo, Sweden). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1964-1966.

The P40 engine is a 40 kW four cylinder double-acting Stirling engine designed to be a reliable test engine that could be used for the development of Stirling specific parts. The P40 engine is described, with particular attention given to cycle analysis, heater head design, engine block, drive unit, and engine tests. Data on engine power and efficiency are presented.

Stirling engine power system development and test results. W. D. Richards (GE Valley Forge Space Center, Philadelphia, Pa.) and D. Lehrfeld (North American Philips Laboratories, Briarcliff Manor, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 1967-1970.

The Stirling Isotope Power System (SIPS) presented in this paper was originally designed to demonstrate the application of an isotope powered dynamic system for terrestrial and future space application. As a result of changes in the mission objectives, DOE redirected the SIPS Program to a technology demonstration program and eliminated the need for an Isotope Heat Source (IHS). The heat source for this developmental effort is an Electric Heat Source (EHS) which is a facsimile of the aforementioned IHS. The program has proceeded with the development of the power conversion system through design, fabrication and system-level performance evaluation.

(Author)

A80-48454 # Stirling engines for developing countries. W. T. Beale, J. G. Wood, and B. J. Chagnot (Sunpower, Inc., Athens, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 1971-1975.

Simple Stirling engines for non-automotive use have been developed to the point where commercial production is feasible. Their undemanding fuel requirements, durability and ease of manufacture and repair make them particularly suitable for use in developing countries where solar energy or biomass derived fuels are available. Slightly pressurized air engines in the 1 kW shaft power range can show engine thermal efficiency in the 15-20% range with simple heat exchangers. Free cylinder engines are cheap, rugged and work well as irrigation pumps, and in other roles accessible to reciprocating motion. Linear alternator engines are more expensive but neverthleless very easy to make and durable. Very simple cooling engines may be made in the Duplex Stirling form, in which a free piston heat engine drives a directly attached Stirling heat pump. These are useful for food refrigeration and air conditioning. (Author)

A80-48456 # Applications of free-piston Stirling engines. W. Rifkin, R. Vincent, and G. Benson (ERG, Inc., Oakland, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics Inc., 1980, p. 1982-1986. 9 refs.

Free-piston Stirling engines (FPSE) are ideal for many applications because of their load-coupling and multi-heat source capability, smooth and quiet operation, long lifetime, and high efficiency. Their low production and maintenance costs, together with their high efficiency and ability to use inexpensive heat sources, provide attractive life-cycle costs. This paper describes ERG's FPSE designs for pumping fluid, generating electricity, and pumping heat that range from a 10 W cryocooler to 1 MW/cylinder electric and hydraulic output power plants having over 60% plant efficiencies. Overall system designs incorporating ERG's FPSE into current and developing applications are presented along with detailed performance results obtained from validated computer programs. (Author)

A80-48472 # Progress in the development of small flame heated thermionic energy converters. R. Henne, M. V. Bradke, and W. Weber (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für technische Physik, Stuttgart, West Germany). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2089-2094.

It is shown that the use of Inconel 601/Mo produced by explosive cladding is a possible solution to the hot shell problem relating to flame-heated thermionic converters. Attention is also given to cermet (ZrO2-Mo) electrode fabrication, and to improvements in the plasma spray technique applied to hot shell attachment. The power and current-voltage characteristics of flame-heated and electrically heated diodes with ZrO2-Mo emitters and collectors are presented. (Author)

A80-48473 # Combustion performance of CVD silicon carbide thermionic diodes. D. B. Goodale, P. Reagan, G. Miskolczy, D. Lieb, and F. N. Huffman (Thermo Electron Corp., Waltham, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2095-2097. Contract No. DE-AC02-76ET-11292.

Many terrestrial applications for thermionic energy conversion require that the electrodes be protected from a combustion

atmosphere. Silicon carbide fulfills the requirements for such a hot shell and has the following properties: highly resistant to an oxidizing atmosphere, vacuum tight, strong at high temperature, reasonable thermal conductivity, inexpensive, and simple to fabricate. Composite hot shells combine a protective shell and the emitter surface into one unit. The composite shell consists of layers made from three materials: silicon carbide, graphite, and tungsten. The graphite forms a mechanical and chemical barrier between the silicon carbide hot shell and the tungsten emitter. Three converters utilizing composite shells have been built and tested in a flame-fired furnace. One converter operated for more than 5000 hours at an average emitter temperature of 1630 K. A second converter operated for 3000 hours at the same emitter temperature. (Author)

A80-48474 # Utilization of low temperature insulators and seals in thermionic converters. M. D. Smith, M. L. Manda, and E. J. Britt (Rasor Associates, Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2098-2102. 10 refs. Contract No. DE-AC02-76ET-11293.

A cylindrical thermionic converter has been designed, fabricated and tested to investigate the feasibility of using low temperature organic sealing materials in thermionic converters. Ordinarily these materials cannot be used because of their instability in cesium vapor at high operating temperatures. This converter overcomes this limitation by using gas-buffered heat pipe principles. A power density of 6 W/sq cm and a barrier index of 1.92 eV were achieved at 1600 K with this 'cold seal' converter. No degradation of the polymer seal was observed. (Author)

A80-48476 \* # Thermionic converter output as a function of collector temperature. G. Stark, M. Saunders, and D. Lieb (Thermo Electron Corp., Waltham, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seartle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2107-2111. Contract No.

JPL-955009.

Surprisingly few data are available on the variation of thermionic converter output with collector temperature. In this study the output power density has been measured as a function of collector temperature (at a fixed emitter temperature of 1650 K) for six converters with different electrode combinations. Collector temperatures ranged from 750 to 1100 K. For collector temperatures below 900 K, converters built with sublimed molybdenum oxide collectors gave the best performance. (Author)

A80-48477 • # Heat flux at the thermionic collector. K. Shimada (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2112-2116. 7 refs. Contract No. NAS7-100.

Heat flux arriving at the thermionic collector is theoretically considered to be composed of an electron heating term, proportional to the output current, plus the radiation and conduction terms. However, the measured electron heating term is always larger than what one would expect from the accepted theory. In this paper, the electron heating term at the collector is theoretically calculated as a sum of the conventional electron heating term and the heat flux which is carried into the collector by the random plasma current. The arriving random electrons and ions are considered to recombine nonradiatively at the collector surface after imparting their kinetic energies to the collector, in addition to the ionization potential energy. In this process, random electrons do not lose their potential energy equal to the collector work function, since they do not contribute to the output current.

(Author)

A80-48481 # Twenty years of experience with well-water-source heat pumps at Battelle's Columbus Laboratories. R. D. Fischer, C. F. Holt, S. G. Talbert, and T. E. Maloy (Battelle Columbus Laboratories, Columbus, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2131-2138.

The paper describes two similar heat-pump systems installed 20 years ago, which are still providing the primary comfort-conditioning needs of four general purpose small laboratory and office buildings with a total floor area of approximately 320,000 sq ft. Descriptive information is provided on the well field from which water is drawn to provide condenser cooling and evaporator heating in cooling and heating operational modes. Monthly well-water consumption and electrical power consumption of the compressor motors are given for 13 years. Yearly maintenance procedures, operational challenges, conclusions, and future plans are discussed. (Author)

A80-48490 # Energy conversion considerations of the STARFIRE commercial fusion power plant. C. C. Baker, M. A. Abdou (Argonne National Laboratory, Argonne, III.), D. A. DeFreece, C. A. Trachsel (McDonnell Douglas Astronautics Co., St. Louis, Mo.), D. Graumann (General Atomic Co., San Diego, Calif.), and J. Kokoszenski (Ralph M. Parsons Co., Pasadena, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2182-2195. 5 refs. Research supported by the U.S. Department of Energy.

STARFIRE is a conceptual design for a commercial tokamak power plant based on the deuterium/tritium/lithium fuel cycle. STARFIRE operates in a steady state mode with the plasma current driven by lower hybrid RF. The plasma impurity control and exhaust system is based on the limiter/vacuum concept. The reactor has a 7-m major radius and produces 4000 MW of thermal power with an average neutron wall load of 3.6 MW/sq m. The first wall/blanket structure is PCA stainless steel. A solid neutron multiplier (Zr5Pb3) and a solid tritium breeder (LiAlO2) are utilized. The primary coolant is pressurized water (15.2 MPa) with inlet and outlet temperatures of 280 C and 320 C, respectively. (Author)

A80-48491 # The Engineering Test Facility - The next major development in the U.S.A. fusion program. W. R. Becraft (General Electric Co., Fairfield, Conn.; Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc.,

1980, p. 2196-2200. 7 refs. Contract No. W-7405-eng-26.

The vehicle by which the fusion program would move into the engineering testing phase of fusion power development is designated the Engineering Test Facility (ETF). The progress toward the design and construction of the ETF will reflect the significant achievements of past, present, and future experimental tokamak devices. The ETF would provide a test-bed for reactor components in the fusion environment. In order to initiate preliminary planing for the ETF decision, the Office of Fusion Energy (OFE) established the ETF Design Center activity to prepare the design of the ETF. This paper describes the design status of the ETF and discusses some highlights of the TFTR R&D work. (Author)

A80-48492 # The reversed-field pinch fusion reactor. R. L. Hagenson (Science Applications, Inc., Ames, Iowa) and R. A. Krakowski (California, University, Los Alamos, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2201-2213. 21 refs. Research sponsored by the U.S. Department of Energy.

A conceptual engineering design of a fusion reactor based on plasma confinement in a toroidal reversed-field pinch (RFP) configuration is described. The plasma is ohmically ignited by toroidal plasma currents which also inherently provide the confining magnetic fields in a toroidal chamber having major and minor radii of 12.7 and 1.5 m, respectively. The DT plasma ignites in 2-3 s and undergoes a transient, unrefueled burn at 10-20 keV for about 20 s to give a DT burnup of about 50%. The 5-s dwell period between burn pulses for plasma quench and refueling allows steady-state operation of all thermal systems outside the first wall; no auxiliary thermal capacity is required. Tritium breeding occurs in a granular Li2O blanket which is packed around an array of radially oriented water/steam coolant tubes. Accounting for all major energy sinks yields a cost-optimized system with a recirculating power fraction of 0.17; the power output is 750 MWe(net). (Author)

A80-48493 # TRACT A small fusion reactor based on near-term engineering. H. J. Willenberg, L. C. Steinhauer, A. L. Hoffman, T. L. Churchill, and P. H. Rose (Mathematical Sciences Northwest, Inc., Bellevue, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 2214-2220. 10 refs. Research supported by the Electric Power Research Institute.

A magnetic fusion reactor concept is described which may lead to small, power-producing fusion reactors using reasonable extensions of existing technology. The TRACT plasma heating and formation technique is the subject of a current experimental program, and is described in this paper. The key technologies associated with a TRACT reactor are identified and potential solutions described. These include the pulsed power supply and switching technology for a compound magnet, heating and damage to an insulating first wall, and remote maintenance requirements for first wall/blanket replacement. A TRACT fusion pilot plant is described which can produce net electric power with a reactor which is only nine meters high and six meters in diameter. The capital cost of the TRACT pilot plant should be in the \$100 million range. Possible concepts for scaling this concept to larger sizes are described, and cost scaling models are presented. (Author)

A80-48495 # The Spheromak fusion reactor. A. M. M. Todd (Grumman Aerospace Corp., Princeton, N.J.), R. E. Olson, J. G. Gilligan, and G. H. Miley (Illinois, University, Urbana, Ill.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2229-2236. 20 refs. Research supported by the Electric Power Research Institute; Contract No. EY-76-C-02-3073.

Recent interest in the Spheromak fusion concept stems from an improving experimental data-base, predictions of confinement scaling and equilibrium similar to a tokamak, and an innovative linear reactor design. A global reactor computer model has been developed based on two-dimensional MHD equilibrium and stability theory. Overall design performance indicates flexibility in reactor sizes (100 MWe to more than 1 GWe) within the constraints of a moderate technology demand. Engineering features of the Spheromak concept are also highlighted. (Author)

A80-48496 # An engineering development plan for inertial confinement fusion. J. A. Blink (California, University, Livermore, Calif.) and J. A. Maniscalco (TRW, Inc., Redondo Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2237-2244. 14 refs. Contract No. W-7405-eng-48.

The paper describes a preliminary analysis of engineering development required for a liquid metal wall engineering test facility

for inertial confinement fusion. Attention is given to the HYLIFE concept and HYLIFE engineering test facility experiments. HYLIFE (High Yield Lithium Injection Fusion Energy converter) is a liquid metal wall concept designed to convert pulsed fusion energy to steady thermal energy in a structure that need not be replaced during the 30-year plant lifetime. Analyses at LLNL indicate that high yield, low-repetition-rate fusion pulses (2700 MJ, 1 Hz) can be converted to thermal power (about 3200 MWT) in a reasonably sized chamber.

A80-48497 \* # Validation of published Stirling engine design methods using engine characteristics from the literature. W. R. Martini (Martini Engineering, Richland, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2245-2250. 29 refs. Research supported by the U.S. Department of Energy and NASA.

Four fully disclosed reference engines and five design methods are discussed. So far, the agreement between theory and experiment is about as good for the simpler calculation methods as it is for the more complicated methods, that is, within 20%. For the simpler methods, a one number adjustable constant can be used to reduce the error in predicting power output and efficiency over the entire operating map to less than 10%. (Author)

A80-48498 # A state space analysis of a symmetrical compounded free piston Stirling engine. L. F. Goldberg (Witwatersrand, University, Johannesburg, Republic of South Africa). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2251-2257. 7 refs.

A symmetrical compounded free piston Stirling engine concept is used as a case study to show the applicability of a state space control analysis in assessing the performance of a conceptual design. A maximum performance envelope is established in the state space as a function of 16 describing base parameters such that the performance of any real prototype engine will fall within the envelope. An outline of the state space analysis as well as some of the more significant engine performance characteristics are presented and discussed. (Author)

A80-48499 # Investigation of a Philips MP 1002 CA Stirling engine. M. A. Clarke, G. T. Reader (Royal Naval Engineering College, Plymouth, England), and J. Slowley (Bath, University, Bath, England). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2258-2264. 6 refs.

In this investigation the Philips MP 1002 CA single cylinder, piston-displacer Stirling engine was analyzed both experimentally and theoretically. The test data were compared to those obtained by analytical predictions using both convection and radiation models and an experience factor was defined. The mass flow rates of the propane and combustion air were measured so that the effects of the air-fuel ratio on engine output could be investigated. Theoretical models were developed for the transfer of heat by convection, conduction and radiation within the heater section of the engine and compared to the empirical data contained in the energy balance. The parameters that were most readily altered in the Philips engine as tested were the mean cylinder pressure, the cylinder head temperature and the engine speed. The maximum brake power output of 0.69 kW occurred at a mean cylinder pressure of 14.78 bar, a cylinder heat temperature of 800 C and an engine speed of 1500 rpm. At this point the maximum value of brake thermal efficiency of 10.14% was achieved, with a combustion equivalence ratio of 1.39.

A80-48500 # Nodal analysis of miniature cryogenic coolers.
R. C. C. Ho, M. E. Howson, and P. L. Boland (Raytheon Co., Missile

Systems Div., Bedford, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 2265-2273. 16 refs.

A hybrid method for the detailed analysis of Stirling cycle machines based on a modified nodal approach is presented. A major feature of the method is that the solution of simultaneous nonlinear algebraic equations representing the fluid nodes eliminates instabilities associated with numerical integration approaches. As a result, the modeling of large numbers of fluid nodes and the use of relatively large time steps are possible. This solution exhibits inherent stability with time step sizes which allow detailed analysis without prohibitively high computational costs.

B.J.

A80-48501 # An analytical solution for a Stirling machine with an adiabatic cylinder. C. D. West (Westware Co., Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2274-2277. 12 refs.

This paper derives an analytical, closed-form expression for the output of a Stirling-like machine with an adiabatic cylinder. The equation predicts that there is a minimum temperature difference below which there is no net power output. This effect, although known from computer simulations and in practice, is not predicted by the more restrictive Schmidt equation, nor is it a feature of the pseudo-Stirling cycle of Rallis and Urielli. (Author)

A80-48502 # Regenerative engines with dense phase working fluids - The Malone cycle. G. Walker (Calgary, University, Calgary, Alberta, Canada). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2278-2284. 7 refs.

It is shown that substantial improvement of the specific output of regenerative thermal machines may be achieved by the use of alternate working fluids, which experience a substantial change in density between the cold compression space and the hot expansion space. Such working fluids include a two-phase, two-component mixture (e.g., air and water), liquid working fluids (e.g., water), or reactive working fluids, (e.g., nitrogen tetroxide). These may collectively be termed dense phase working fluids on the regenerative thermodynamic cycle on which they operate as the Malone cycle.

B.J

A80-48521 Transient behaviour of wind energy systems. S. Sivasegaram (Peradeniya, University, Peradeniya, Sri Lanka). Wind Engineering, vol. 4, no. 2, 1980, p. 53-63.

A study is presented of the transient response of wind energy systems to sudden changes in wind speed and to fluctuating wind speeds using generalized representations of rotor and load characteristics. It is shown that analytical solutions are possible in a limited number of cases; the response time is dependent on the magnitude of the change in wind speed, and the time constant of the control theory for small perturbances is frequently insufficient to describe system behavior. The extraction of the excess energy available in the wind due to fluctuations of wind speed is affected by the nonlinearity of the characteristics and by frequency and amplitude of fluctuations. It is concluded that small perturbation models are inadequate for describing the system.

A.T.

A80-48522 A simulation model for wind electric systems. B. N. Haack (Ball State University, Muncie, Ind.). *Wind Engineering*, vol. 4, no. 2, 1980, p. 64-75. 10 refs.

A computer operated simulation model for the examination of wind electric systems is described. Components included in this model are wind speed observations collected at first order meteorological stations, residential electrical consumption data from sampled households, and characteristics of wind electric equipment. The

model simulates wind electric system performance for one year using wind speed and residential demand observations at three hour intervals. Primary outputs from the model include available wind energy, generator output, back-up utilization, energy loss due to the inefficiencies of the battery and inverter, and percent of consumer demand satisfied by the wind. Changes in one or several input values in the model can provide information on how those changes affect total system performance. Such information is difficult to obtain by other means. The model can be a very useful tool for examining current and future wind electric systems. (Author)

A80-48523 Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills. P. A. Taylor (Department of the Environment, Atmospheric Environment Service, Downsview, Canada): Wind Engineering, vol. 4, no. 2, 1980, p. 76-79. 8 refs.

A80-48525 Small windmills in Denmark. H. Petersen (Riso National Laboratory, Roskilde, Denmark). Wind Engineering, vol. 4, no. 2, 1980, p. 87-114.

The report describes a project for small windmills funded by the Ministry of Energy. The test plant is described and a survey of Danish windmills is presented. Some requirements for windmills are mentioned and regulations governing the interface between grid-connected windmills and the electric utilities are explained and discussed.

(Author)

A80-48763 \* Use of generalized population ratios to obtain Fe XV line intensities and linewidths at high electron densities. S. O. Kastner and A. K. Bhatia (NASA, Goddard Space Flight Center, Laboratory for Astronomy and Solar Physics, Greenbelt, Md.). Physical Review A - General Physics, 3rd Series, vol. 22, Aug. 1980, p. 560-566. 15 refs.

A generalized method for obtaining individual level population ratios is used to obtain relative intensities of extreme ultraviolet Fe XV emission lines in the range 284-500 Å, which are density dependent for electron densities in the tokamak regime or higher. Four lines in particular are found to attain quite high intensities in the high-density limit. The same calculation provides inelastic contributions to linewidths. The method connects level populations and level widths through total probabilities t(ij), related to 'taboo' probabilities of Markov chain theory. The t(ij) are here evaluated for a real atomic system; being therefore of potential interest to random-walk theorists who have been limited to idealized systems characterized by simplified transition schemes. (Author)

A80-48765 Experimental evidence of charge-exchange recombination of highly ionized iron and titanium in Princeton large torus. S. Suckewer, E. Hinnov, M. Bitter, R. Hulse, and D. Post (Princeton University, Princeton, N.J.). Physical Review A - General Physics, 3rd Series, vol. 22, Aug. 1980, p. 725-731. 15 refs. Contract No. DE-AC02-76CH-03073.

The observed behavior of the emissivities of boronlike Fe XXII, lithiumlike Fe XXIV and Ti XX, and the heliumlike Fe XXV ions in the Princeton large torus tokamak during high-power neutral (H(0) or D(0)) beam heating is described. A substantial lowering of the dominant ionization state in the center of the discharge, while the electron temperature is rising, is attributed primarily to increased recombination rate of the ions through charge exchange with neutral hydrogen. This interpretation is supported by the different space and time behavior or the lithiumlike and boronlike ions of comparable ionization potentials, and by comparisons of neutral beam heating of the plasma with ion cyclotron resonance heating, which does not appreciably change the neutral hydrogen concentration. The observations are compared with approximate zero-dimensional model calculations, using experimental plasma conditions and estimated charge-exchange rates. (Author)

A80-49058 Alteration of Pfirsch-Schlüter transport in tokamaks by all four external sources. K. H. Burrell (General Atomic

Co., San Diego, Calif.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1526-1531. 26 refs. Contract No. DE-AT03-76ET-51011.

Tokamak energy and particle transport are calculated for a plasma in the Pfirsch-Schlüter regime containing all possible external sources: particle, momentum, heat, and heat momentum. The effect of the last source has never been considered previously; its presence makes possible simultaneous control of the impurity flux into the plasma and of the heat flux from the plasma. Examples are given showing that such control is possible with existing neutral beam or RF sources:

A80-49067 Theoretical multiple beam overlap from channel transport of intense particle beams. T. P. Wright and J. A. Halbleib, Sr. (Sandia Laboratories, Albuquerque, N. Mex.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1603-1611. 22 refs. Contract No. DE-AC04-76DP-00789.

The implications of collisionless single-particle trajectory motion on transport and overlap of high-power electron and light-beams in plasma channels are discussed. Upper limits to the current density gain are derived for electrons and ions. Geometrical considerations of spherically converging multi-disk plasma channels are analyzed and a transcendental equation is obtained which determines the optimum cone angle for multiple disk configurations. A description of the numerical model used in the trajectory calculations is given.

A80-49068 Relativistic-electron-beam/target interaction in plasma channels. J. A. Halbleib, Sr. and T. P. Wright (Sandia Laboratories, Albuquerque, N. Mex.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1612-1619. 19 refs. Contract No. DE-AC04-76DP-00789.

A model describing the transport of relativistic electron beams in plasma channels and their subsequent interaction with solid targets is developed and applied to single-beam and multiple-beam configurations. For single beams the targets consist of planar tantalum foils and, in some cases, cusp fields on the transmission side of the foils are employed to improve beam/target coupling efficiency. In the multi-beam configurations, several beams are arranged in wagonwheel fashion so as to converge upon cylindrical targets, consisting of either hollow tantalum or solid graphite cylinders, located at the hub. For 0.3-cm beam radii that are less than or equal to the channel radii, mean specific power depositions up to about 17 TW/g per MA of injected beam current are obtained for single beams; 12-beam results are typically an order-of-magnitude less. The corresponding enhancements are up to five times the collisional stopping power for either single or multiple beams. Substantial improvement is predicted for the multi-beam interaction should future channel technology permit transport at higher current densities in smaller channels.

(Author)

A80-49069 A model for laser driven ablative implosions. C. E. Max, W. C. Mead (California, University, Livermore, Calif.), and C. F. McKee (California, University, Livermore and Berkeley, Calif.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1620-1645. 47 refs. Contract No. W-7405-eng-48.

A theoretical model is presented describing the spatial structure and scaling laws of laser driven ablative implosions. The effect of inhibited electron thermal transport is explicitly included. The theory is in excellent agreement with results from a computer hydrodynamics code, under conditions when heat flow is flux-limited at the critical surface and suprathermal electrons do not form a dominant energy transport mechanism.

(Author)

A80-49071 Parametric decay into ion cyclotron waves and drift waves in multi-ion species plasma. M. Ono (Princeton University, Princeton, N.J.), M. Porkolab (MIT, Cambridge, Mass.), and R. P. H. Chang (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). Physics of Fluids, vol. 23, Aug. 1980, p. 1656-1674. 46 refs. Contract No. EY-76-C-02-3073.

Parametric decay processes near the ion cyclotron frequency are investigated experimentally and theoretically in multi-ion species plasmas. The relevant theoretical dispersion relation of the parametric coupling is derived, including the ion drift motion. Experimental data obtained in the Princeton L-4 device verify these

#### **05 ENERGY CONVERSION**

theoretical predictions in some detail. In a helium-neon plasma, the relative ion drift motion excites electrostatic ion cyclotron waves (the kinetic ion-ion hybrid mode) when the pump frequency is greater than the sum of the gyrofrequencies of He and Ne. In a region of large density gradient, the ion drift motion also excites low-frequency drift waves when the pump frequency is greater than the sum of the He gyrofrequency and the product of the azimuthal wave number and the drift potential. The experimental data are found to agree well with the theory. The relevance of these processes to ion cyclotron heating of fusion plasmas is discussed. (Author)

A80-49072 Parametric excitation of ion quasi-mode by the pump near the ion cyclotron frequency. M. Ono (Princeton University, Princeton, N.J.), M. Porkolab (MIT, Cambridge, Mass.), and R. P. H. Chang (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). Physics of Fluids, vol. 23, Aug. 1980, p. 1675-1681. 13 refs. Contract No. EY-76-C-02-3073.

Parametric excitation of a nonresonant ion quasi-mode in a low density (i.e., the ion plasma frequency is approximately equal to Omega(i)) plasma is observed when the pump frequency is equal to or greater than 2 Omega(i). From the interferometry measurement, the lower sideband is identified to be the cold lower hybrid wave and the low-frequency mode is shown to be a nonresonant ion quasi-mode. The dependence of the excitation process and the threshold upon density has been measured and was found to agree well with theory. The ion heating associated with this decay process is also observed. Such processes may take place near the plasma surface during ion cyclotron range of frequency heating experiments in tokamaks. (Author)

A80-49074 Bifurcation of sharp boundary beta=1 multipole equilibria. R. L. Spencer (Wisconsin, University, Madison, Wis.). Physics of Fluids, vol. 23, Aug. 1980, p. 1691-1697. 19 refs. Research supported by the U.S. Department of Energy and Danforth Foundation.

The bifurcation of sharp boundary magnetohydrodynamic equilibria in linear multipoles of arbitrary order is studied using the hodograph method. In the low pressure limit, simple formulas are obtained for the shapes of multipole cusp equilibria. In the high pressure limit the equilibria are found to bifurcate; two different equilibria may exist for the same values of the external parameters. It is conjectured that a similar bifurcation will be encountered in the calculation of diffuse multipole equilibria at high beta. (Author)

A80:49075 Observations of fluctuating omega sub p emission in Alcator tokamaks. I. H. Hutchinson and S. E. Kissel (MIT, Cambridge, Mass.). *Physics of Fluids*, vol. 23, Aug. 1980, p. 1698-1703. 17 refs. Contract No. DE-AC02-78ET-5103-A002.

Measurements are presented of fluctuating millimeter-wave radiation from the Alcator tokamaks. Its characteristics are (1) rapid modulation, approaching 100% with rise time 3-4 microseconds, (2) very narrow line width, less than 5 GHz at the plasma frequency, and (3) extremely large intensity, up to 200 times thermal. These characteristics distinguish this radiation from the steady omega sub pe emission previously documented and are interpreted as indicating nonlinear conversion of electrostatic oscillations as the origin of the radiation. (Author)

A80-49098 Magnetic-pressure acceleration of cylindrical liners by the pulse generators for relativistic electron beams, S. G. Alikhanov, L. I. Rudakov, V. P. Smirnov, and I. R. lampol'skii. (Pis'ma v Zhurnal Tekhnicheskoi Fiziki, vol. 5, Nov. 1979, p. 1395-1397.) Soviet Technical Physics Letters, vol. 5, Nov. 1979, p. 587, 588. 6 refs. Translation.

A theoretical discussion of the magnetic-pressure acceleration of cylindrical liners is presented. It is shown that such acceleration is suitable for inertial confinement fusion. This development is the result of progress in two fields: research on magnetically driven liners and research on relativistic electron beams, which led to the idea of transporting energy from a generator to a target along a magnetically insulated line.

B.J.

A80-49209 Destabilization of drift-universal eigenmodes by toroidal effects. K. W. Hesketh (EURATOM and U.K. Atomic Energy Authority Fusion Association, Culham Laboratory, Abingdon, Oxon, England). *Nuclear Fusion*, vol. 20, Aug. 1980, p. 1013-1019. 7 refs.

Numerical solutions are obtained for an eigenmode equation representing long-wavelength drift modes in a tokamak, incorporating the passing electron Landau resonance. It is shown that toroidal effects can destabilize the slab drift wave, that is, the electron Landau resonance appropriate to toroidal geometry is sufficient to overcome the residual shear damping characteristics of toroidal systems.

V.T.

A80-49414 # Contribution to the theory of the free-field induction-type MHD engine (K teorii induktsionnogo MGD-dvizhitelia so svobodnym polem). V. I. lakovlev. *PMTF-Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki*, May-June 1980, p. 105-116. 9 refs. In Russian.

From the present analysis it can be seen that allowance for the longitudinal edge effect in the evaluation of the energetic characteristics of MHD propulsion reduces markedly the values predicted by Phillips (1962) for a given magnetic field intensity. At the same time, the magnetic field required to obtain a given efficiency value is higher than the predicted value. A method of improving propulsion efficiency by 'amplitude modulation' is proposed.

V.P.

A80-49720 Fuel cell systems for vehicular applications. D. K. Lynn, J. B. McCormick, R. E. Bobbett, C. Derouin (California, University, Los Alamos, N. Mex.), and W. J. Kerwin (Arizona, University, Tucson, Ariz.). Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800059. 12 p. Research sponsored by the U.S. Department of Energy.

The vehicular applications of fuel cells are evaluated for both technical feasibility and economic potential. Four vehicle types, the city bus, highway bus, delivery van, and general-purpose consumer car are selected for evaluation. The results of computer simulations are utilized to illustrate a number of important system design considerations in configuring a fuel cell/battery electric vehicle. A fuel-cell-powered golf cart being used as an engineering test bed is described.

A80-49724 \* An automotive transmission for automotive gas turbine power plants. J. C. Polak (General Motors Corp., Detroit Diesel Allison Div., Detroit, Mich.). Society of Automotive Engineers, Conaress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800099. 7 p. Research supported by the U.S. Department of Energy; Contract No. DEN3:28.

A joint government-industry program was initiated to investigate the two-shaft gas turbine concept as an alternative to present-day automotive powerplants. Both were examined, compared and evaluated on the basis of the federal automotive driving cycle in terms of specific fuel/power/speed characteristics of the engine and the efficiency and performance of the transmission. The results showed that an optimum match of vehicle, gas turbine engine, and conventional automatic transmission is capable of a significant improvement in fuel economy. This system offers many advantages that should lead to its wide acceptance in future vehicles. (Author)

A80-50351 Gas turbines for automotive use. Edited by J. P. O'Brien. Park Ridge, N.J., Noyes Data Corp. (Energy Technology Review, No. 54), 1980. 349 p. \$42.

A review of applications of gas turbine engines in the passenger automotive field is presented. Engine configurations and components including compressors, combustors, and heat exchangers are described along with applicable aerospace technology. Metallic material manufacture and costs are analyzed, and ceramic technology for heat engines is discussed. Engine fuel consumption, emissions, and

torque-speed characteristics are examined; uses of gas turbine powered inter-city and urban buses are considered. A.T.

A80-50356 # Momentum transfer of laser radiation to inhomogeneous dielectrics. V. F. Lawrence. New South Wales, University, Faculty of Science, Doctor of Philosophy Thesis, 1978. 181 p. 126 refs. Australian Research Grants Committee Grant No. B75/15538.

The transfer of momentum from a laser pulse of various intensities into a plasma formed from an inhomogeneous dielectric is examined in view of the importance of the process to studies of laser fusion. The effects of low reflectivities in the inhomogeneous plasma in the case of a Rayleigh-like density profile are discussed using analytical and step-wise approximation methods. Consideration is then given to the generation of the nonlinear force and the consequent formation of solitons and cavitons and to the theory of optical constants in the absorption of laser radiation. Use is made of a one-dimensional plane wave code allowing for electron and ion thermal equilibration and assuming a one-fluid model where Debye shielding effects ensure the quasi-neutrality of the plasma to calculate the properties of the laser-plasma interaction at times of 10 to the -13th to to the -12th seconds. Experimental results are presented which confirm the calculations. A.L.W.

A80-50357 # Instability analysis in a nonequilibrium MHD generator. W. M. Hellebrekers. Eindhoven, Technische Hogeschool, Doctor in de technische Wetenschappen Thesis, 1980. 99 p. 43 refs.

A study was made of fluctuations in a nonequilibrium MHD the accel column length on the source performance is also discussed. The results can be useful in the design of high power, high energy neutral beam sources for plasma heating applications in fusion devices.

A80-50507 Safety studies on Li/SO2 cells. IV - Investigations of alternate organic electrolytes for improved safety. A. N. Dey and R. W. Holmes (Duracell International, Inc., Burlington, Mass.). Electrochemical Society, Journal, vol. 127, Sept. 1980, p. 1877-1881. 9 refs. Grant No. DAAB07-77-C-0472.

The lithium reactivity of a variety of organic solvents and their mixtures was determined by measuring the exotherm initiation temperature of the organic solvents with Li using DTA. The least reactive solvent and mixtures were used to prepare electrolytes comprising 1M LiBr and 70% liquid SO2 and the electrical conductivities of these electrolytes were measured at various temperatures. Eight electrolytes were found to have equivalent or better conductivities and significantly less reactivity towards Li compared to the state-of-the-art electrolyte comprising LiBr, acetonitrile, and SO2. Some of the electrolytes showed a reduction in conductivity on storage. (Author)

A80-50509 Safety studies on Li/SO2 cells. V - Effect of design variables on the abuse resistance of hermetic D cells. A. N. Dey (Duracell International, Inc., Burlington, Mass.). (Electrochemical Society, Meeting, Los Angeles, Calif., Oct. 14-19, 1979.) Electrochemical Society, Journal, vol. 127, Sept. 1980, p. 1886-1890. Grants No. DAAB07-77-C-0458; No. DAAB07-78-C-0535.

The effect of cell design variables such as stoichiometric ratios of Li:SO2, electrode area, electrolyte salt, SO2 content of the electrolyte, etc. on the abuse resistance of the hermetic Li/SO2 D cells on force-discharge, especially at -30 deg C at a current of 2A, was evaluated. Both the Li:SO2 ratio and the current density of operation were found to be important design parameters from the safety standpoint. Lithium-limited cell designs were found to be safer than the lithium-rich cell designs for a given current density of operation. (Author)

A80-50666 Theory of an inductive free-field MHD propulsor. V. I. lakovlev (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR). (Akademiia Nauk SSSR, Doklady, vol. 249, no. 6, 1979, p. 1342-1345.) Soviet Physics - Doklady, vol. 24, Dec. 1979, p. 976-978. 7 refs.

The paper investigates the energy characteristics of a free-field inductive MHD-system. The model body set into motion is taken to be a flat plate of finite width and infinite length in a boundless conducting fluid. The problem is one of determining the electromagnetic field parameters necessary to set the plate into motion. The use of current-amplitude modulation to control the energy parameters of the MHD system is discussed.

B.J.

A80-50721 Maximum windmill efficiency. R. J. Greet (New Haven, University, West Haven, Conn.). *Journal of Applied Physics*, vol. 51, Sept. 1980, p. 4680, 4681.

Consideration is given to the maximum efficiency obtainable from a windmill as predicted by one-dimensional fluid flow theory. Considerations of the conservation of mass, energy and linear momentum for the one-dimensional flow of an incompressible fluid through an active windmill blade section are used to derive an expression for the windmill efficiency, or power coefficient, as a function of thrust force on the frame and mean stream velocity. It is noted that the present expression cannot be differentiated to obtain a theoretical maximum power output as was done by Betz (1927) on the basis of an incorrect statement of the energy balance.

A.L.W.

A80-50760 Photoelectrochemistry with p-Si electrodes - Effects of inversion. J. A. Turner, A. J. Nozik (Solar Energy Research Institute, Golden, Colo.), and J. Manassen. *Applied Physics Letters*, vol. 37, Sept. 1, 1980, p. 488-491. 13 refs. Research supported by the U.S. Department of Energy.

Reduction of chemical species with redox potentials above the apparent conduction-band edge of p-Si were found to be possible with illuminated p-Si contact with nonaqueous electrolytes. Analysis of the wavelength dependence of the photoreduction current and capacitance data as a function of electrode potential, ac signal frequency, and light intensity shows that this supra-conduction-band-edge reduction is the result of band-edge unpinning, rather than the result of a hot-electron injection process. The band-edge unpinning is caused by the formation of an inversion layer in illuminated p-Si.

(Author

A80-50907 Geothermal energy - An overview. A. M. Stone (Johns Hopkins University, Laurel, Md.). Johns Hopkins APL Technical Digest, vol. 1, Apr. June 1980, p. 78-87. 15 refs.

It is noted that considerable technical difficulty persists (but is slowly being overcome) in geothermal reservoir discovery, the proper engineering of the withdrawal and reinjection wells, and the economic application of heat. By far the most abundant resource available at depths down to 3 km is of relatively low temperature (below about 185 F) and thus is basically useful for the space heating of commercial, industrial, and residential buildings.

B.J.

A80-50909 Ocean thermal energy conversion contribution to the energy needs of the United States. W. H. Avery (Johns Hopkins University, Laurel, Md.). Johns Hopkins APL Technical Digest, vol. 1, Apr. June 1980, p. 101-107. 11 refs.

OTEC utilization in the United States is reviewed with attention given to ammonia synthesis, projected costs, and commercialization. OTEC can provide energy to the United States via direct electric transmission from offshore islands or Gulf of Mexico sites, or via production of an energy-intensive product on an OTEC plantship sited in tropical waters. The projected costs of OTEC ammonia and electricity after 1990 are competitive with projected costs from natural gas, and from coal or nuclear plants.

B.J.

A80-50943 Wind tunnel tests on a 3 m diameter Musgrove windmill. A. C. Willmer (British Aerospace, Aircraft Group, Bristol, England). International Journal of Ambient Energy, vol. 1, Jan. 1980, p. 21-27. Research supported by the Department of Energy.

#### **05 ENERGY CONVERSION**

A 3 m diameter model of a two bladed Musgrove vertical axis windmill has been tested in the British Aerospace wind tunnel at Filton. Tunnel constraints were kept to a minimum by using a low flow blockage and appropriate corrections were applied to the measurements. The results of these tests demonstrate the good performance of this type of windmill. Comparison of the measured performance with predictions from a simple mathematical model show excellent agreement. Maximum loads measured on the windmill are not well predicted by the mathematical model. In order to reconcile measurement and prediction large induced crossflows must be postulated at some blade rotational positions. (Author)

A80-50946 On the selection of working fluids for OTEC power plants. E. N. Ganic and J. Wu (Illinois, University, Chicago, Ill.). Energy Conversion and Management, vol. 20, no. 1, 1980, p. 9-22. 31 refs. Research supported by the U.S. Department of Energy and Argonne National Laboratory.

This paper analyzes the effect of three different working fluids (ammonia, propane, and Freon-114) on the size of OTEC heat exchangers and system performance. Seven different combinations of shell-and-tube heat exchangers are considered. For each combination, a simple computer model of the OTEC power system is used to compare the three fluids. The comparison is made on the basis of A/Wnet, where A is the total heat transfer area (evaporator plus condenser) and Wnet is the net power output of the plant. Overall, ammonia is shown to be the best fluid (i.e., it yields the lowest value of A/Wnet), although in some cases only by a small margin. The thermophysical property that gives ammonia its general superiority is its relatively high thermal conductivity. The paper also discusses heat exchanger design problems associated with liquid entrainment and boiling liquid superheat. (Author)

A80-50947 Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels. E. Levi (New York, Polytechnic Institute, Brooklyn, N.Y.). Energy Conversion and Management, vol. 20, no. 1, 1980, p. 33-39. 8 refs.

An analysis is presented for the diode scheme of power take-off from diagonal conducting wall magnetohydrodynamic channels based on a one-dimensional theory. Basic expressions for the Hall field and current in the channel are obtained and used to derive optimal design parameters and current distributions in the presence and absence of equalizing resistors inserted in series with diodes in the leads. Predictions of current distribution in the inlet connection and short circuit current made by the one-dimensional theory are shown to be in reasonable agreement with experimental results obtained on the U-25 B facility with ballast resistors, and it is noted that taking into account two- and three-dimensional effects will improve prediction accuracy.

A.L.W.

A80-50948 End effects in a MHD channel with diverging electrode walls. P. R. L. Sarma and M. L. Mittal (Indian Institute of Technology, Bombay, India). *Energy Conversion and Management*, vol. 20, no. 1, 1980, p. 41-47. 11 refs. Research sponsored by the Department of Atomic Energy of India.

End effects phenomena in a Faraday type generator with diverging electrode walls for two types of velocity profiles one with a source velocity and the other with a fully developed velocity are discussed. The electric potential is determined numerically using the successive overrelaxation method in polar coordinates. It is found that the viscous forces increase the end losses and create current concentrations on the electrodes even at far distances from the entrance. (Author)

A80-50949 The solution to the gas turbine temperature problem. R. W. Satz (Transpower Corp., Fort Washington, Pa.). Energy Conversion and Management, vol. 20, no. 1, 1980, p. 49-63. 18 refs.

The paper presents a Brayton cycle gas turbine engine which overcomes the previous limitations on temperature at the expander side imposed by the possible expander materials. The proposed engine is a rotary, positive displacement Brayton-type engine in

which each compression expansion mechanism alternately compresses and expands the working fluid, so that the mechanisms remain at approximately the mean temperature of the compressed and expanded gas and much higher operating temperatures can be used. In addition, the rotor is offset from the center of the stator so that the expansion volume is greater than the compression volume. Computer simulation indicates an overall efficiency of 57%, a weight of 4.4482 N/bhp and low hydrocarbon and CO emissions. Compared to the conventional Otto cycle engine, the proposed Brayton cycle engine is expected to provide twice the fuel economy with half the maintenance and at three quarters the original cost.

A.L.W.

A80-50972 A simulation model for wind turbines. H. M. Power (University College, Dublin, Ireland). *Applied Energy*, vol. 6, Sept. 1980, p. 395-399. 9 refs.

Equations of motion to be used in the mathematical modeling of prospective wind turbine designs are examined. It is shown that the product of the moment of inertia and the change with time of the angular velocity of a wind turbine is equal to the difference between generated torque and load torque, and generated torque in turn can be described by one of a series of homogeneous second-degree functions of wind speed and angular velocity. Expressions for the power coefficient corresponding to each torque function are also presented, and it is pointed out that the model parameters can be tuned to data on specific machines according to the dependence of power coefficient on tip-speed ratio.

A.L.W.

A80-51018 Density profiles in tokamaks from electron cyclotron radiation spectra. D. A. Boyd (Maryland, University, College Park, Md.). International Journal of Infrared and Millimeter Waves, vol. 1, Mar. 1980, p. 45-55. 9 refs.

Measurement of the line shape of optically thick and optically thin lines in the electron cyclotron radiation spectrum emitted by a tokamak plasma may yield both electron temperature and density profiles. Currently temperature profiles are routinely extracted from optically thick lines. Consequently, this paper is addressed to the density profile problem. Algorithms for extracting density profiles are outlined in the case of uncontrolled reflection and controlled reflection of the cyclotron radiation within the tokamak vacuum chamber. (Author)

A80-51038

Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in large tokamaks. A. V. Gaponov, V. A. Fliagin, A. Sh. Fiks, A. L. Gol'denberg, V. I. Khizhniak, A. G. Luchinin, G. S. Nusinovich, M. I. Petelin, Sh. E. Tsimring, and V. G. Usov (Akademiia Nauk SSSR, Institut Prikladnoi Fiziki, Gorki, USSR). International Journal of Infrared and Millimeter Waves, vol. 1, Sept. 1980, p. 351-372. 61 refs.

A80-51124 Performance of a low cost cross-wind-axis sail-wind turbine. G. Ahmadi (Shiraz, University, Shiraz, Iran). Energy (UK), vol. 5, Oct. 1980, p. 1045-1052. 21 refs. Research supported by the University of Shiraz.

The performance of a model of a cross-wind axis sail rotor is investigated. Several sail blade types, with high and low chamber, are employed and the effects of wind velocity, blade pitch angles, and external load on the efficiency of the rotor are studied. It is concluded that though the efficiency of the present model is quite low, the rotor and the sail blades have simple designs and it is possible to construct a prototype of this kind of wind turbine in the remote villages of developing countries.

S.S.

A80-51203 Second law and radiation. R. H. Edgerton (Oakland University, Rochester, Mich.). (U.S. Department of Energy, Workshop on the Second Law Analysis of Energy Devices and Processes, Washington, D.C., Aug. 14-16, 1979.) Energy (UK), vol. 5, Aug. Sept. 1980, p. 693-706; Discussion, p. 706, 707. 16 refs.

The available energy of thermal radiation and solar radiation is examined. The extension of the available energy concept to the evaluation of the potential energy conversion in solar converters is outlined. The fundamental question discussed is how much of a given solar radiation flux is convertible to thermodynamic work. The basic

relations for evaluating the available energy in radiation processes are developed. The effects of both the spectral and spatial distribution of the radiation on the available energy are discussed. Atmospheric effects are examined, using NASA standard atmosphere solar spectral distributions. The available energy of the spectral characteristics is compared with the available energy of thermal equilibrium radiation at the same solar flux. This is used to illustrate the available energy losses in thermal energy converters. The technical evaluation of solar energy converters is discussed, based on the available energy of the input energy. A method for evaluating spectral sharing solar conversion devices and solar energy simulators is outlined. (Author)

A80-51459 The influence of contact pressure on the performance of supported gas diffusion electrodes in alkaline H2-02-fuel cells. H. H. Ewe, E. W. Justi, and H. J. Selbach (Braunschweig, Technische Universität, Braunschweig, West Germany). Energy Conversion and Management, vol. 20, no. 2, 1980, p. 75-83. 9 refs.

A80-51464 Describing function method for estimating the performance of a dynamic system having nonlinear-power take-off, with application to wave-power conversion. J. O. Flower (Exeter, University, Exeter, England) and G. F. Knott (Sussex, University, Brighton, England). Energy Conversion and Management, vol. 20, no. 2, 1980, p. 127-134. 6 refs.

A80-51465 Performance characteristics of nonequilibrium MHD generator with fully ionized seed and enlargement of stabilized region. D. Tanaka and Y. Hattori (Kyoto University, Uji, Japan). Energy Conversion and Management, vol. 20, no. 2, 1980, p. 135-144, 10 refs.

A80-51692 Development of a 7 kW H2/O2-fuel cell assembly with circulating electrolyte in a compact modular design. K. Strasser (Siemens AG, Forschungslaboratorien, Erlangen, West Germany). (Electrochemical Society, Meeting, Boston, Mass., May 6-11, 1979.) Electrochemical Society, Journal, vol. 127, Oct. 1980, p. 2172-2177. 13 refs. Research supported by the Bundesministerium für Forschung und Technologie.

A80-51721 The operating region of MHD generators. D. T. Trung and H. K. Messerle (Sydney, University, Sydney, Australia). *IEEE Transactions on Plasma Science*, vol. PS-8, Sept. 1980, p. 269-275. 9 refs.

The concept of an overall operating region for segmented Faraday magnetohydrodynamic (MHD) generators is established. The resulting diagram indicating optimal operating conditions relates generator mass flow rate to inlet stagnation pressure. It provides information on the generator inlet Mach number, the electrical load factor, the total electrical power output, and the percentage enthalpy extraction (PEE) for any possible operating condition of a specific generator. The diagram is a useful tool in specifying the behavior of the generator under changing operational conditions and for anticipating the formation of shock fronts inside the generator channel, an occurrence which is very undesirable from an electrical engineering point of view. Conclusions drawn indicate that the optimal operating range for maximum electrical power output lies on the boundary between the transonic and supersonic flow regimes at relatively low inlet stagnation pressures. The maximum PEE occurs at a somewhat lower power with the electrical loading factor K of about 0.5.

(Author)

A80-52048 # OTEC power system modeling, analysis and design via geometric programming. A. Lavi (Carnegie-Mellon University, Pittsburgh, Pa.). ASME, Transactions, Journal of Energy Resources Technology, vol. 102, Sept. 1980, p. 154-159. 7 refs.

A complex power system may be modeled by a system of inequalities representing the constraints imposed by the physical laws: heat transfer, energy balance, cycle efficiency and so forth. The nature of the resulting mathematical model is such that the terms contain complex expressions involving the design and operating variables of the process. With the addition of an objective function

involving the cost of major system components, a multivariable nonlinear programming problem can be formulated. Seldom does the model lend itself to analytical treatment. This paper is concerned with a specific formulation and solution of nonlinear programming problems which arise in the design of ocean thermal energy conversion (OTEC) power plants. The technique used is geometric programming, GP. It is shown that GP serves as an excellent tool for system analysis because it provides sensitivity information essential to the designer. (Author)

A80-52555 End zone of a frame-type channel with an inhomogeneous flow. V. L. Bobrov, V. Iu. Konoplev, and Iu. V. Makarov. (Magnitnaia Gidrodinamika, Oct.-Dec. 1979, p. 69-72.) Magnetohydrodynamics, vol. 15, no. 4, Apr. 1980, p. 417-419. Translation.

In the present paper, a modification of the Lax-Wendroff method is applied to the numerical analysis of the potential and current fields in the end zone of a channel with segmented electrodes and nonuniform flow. It is shown that in order to determine the position of the first electrode, one must know both the mean values and the spatial distribution of the plasma parameters.

V.P.

A80-52556

Piston type magnetohydrodynamic motor. A.

I. Khozhainov. (Magnitnaia Gidrodinapnika, Oct.-Dec. 1979, p.
The paper deals with the theory of a conduction-type MHD piston engine with a reciprocating motion of the liquid metal. Relations for the piston rate, the apparent mass, and engine efficiency are derived under the assumption of a linear dependence

of the effective resistance on the piston rate. It is assumed that the

flow is laminar and that edge effects are negligible.

A80-52600 Closed-cycle gas turbines for power generation and LNG vaporization. D. Weber (Maschinen-Fabrik Augsburg-Nürnberg AG, Oberhausen, West Germany). *Turbomachinery International*, vol. 21, Sept. 1980, p. 24-30. 6 refs. Research supported by the Bundesministerium für Forschung and Technologie and Commission of the European Communities.

Cooling by LNG (liquefied nitrogen gas) in closed-cycle gas turbines results in double the electrical output of water cooled turbines. A circuit scheme of the LNG turbine is presented with the temperatures and pressures of the cycle. The turbine inlet temperature is limited to 720 C. Pressure level control and bypass control are the two basic types of control applied. The power station has an output of 4 x 100 MW, with four heaters arranged in series. The basic design of the heater, turbine, compressor, recuperator, and vaporizer is given. A cost comparison is made between the closed cycle gas turbine and steam turbine power stations with open rack vaporizer, submerged combustion vaporizer, or both. Using an LNG terminal with a closed-cycle gas turbine for the generation of electric power and LNG vaporization would mean a potential world-wide saving of 2,350 MW thermal power or 4.2 x 10(6) kg of LNG/day by 1985.

R.C.

A80-52971 Thermoelectric MHD with walls parallel to the magnetic field. J. A. Shercliff (Warwick, University, Coventry, England). International Journal of Heat and Mass Transfer, vol. 23, Sept. 1980, p. 1219-1228.

Liquid metal within metal walls under a magnetic field is stirred thermoelectrically if the interfacial temperature is non-uniform. When there are areas of interface parallel to the uniform magnetic field, fast boundary layers occur, exchanging fluid with the central region. Outside these layers, viscosity and inertia may be neglected if the magnetic field is strong. Motions in long ducts of rectangular cross-section, closed cylinders coaxial with the field, and cubical containers are investigated. As the interface temperature is assumed to be known ab initio, the strong effects of heat convection are not explored. (Author)

A80-53473 Mini-OTEC. H. J. White (Natural Energy Laboratory of Hawaii). *International Journal of Ambient Energy*, vol. 1, Apr. 1980, p. 75-88. 5 refs.

Construction and operation of a closed cycle small-scale 18 kW net power generating plant, off the coast of Hawaii designed in the frame of the Ocean Thermal Energy Conversion program (OTEC) is analyzed. A block-diagram of the power system of the plant with the heat exchangers and the turbine generator groups is presented as well as the heat exchanger and turbine/generator characteristics. Cold water pipe/mooring system and deployment are discussed in detail and the results of the experiments are covered, including evaluation of the gas content in the incoming cold water and in the effluent, crude surface current measurements, monitoring of incoming cold water temperature and surface temperature, and water chemistry analysis for the mini-OTEC.

A80-53674 Ocean thermal energy conversion /OTEC/ - A subscale test range. W. Cibosky (TRW, Inc., Ocean and Energy Systems Program Office, Redondo Beach, Calif.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 14-20. Coastal waters provide an inexpensive alternative to laboratory test tanks which are generally inadequate for subscale testing of OTEC systems. These large offshore systems are subject to complex hydrodynamic loading conditions which cannot be duplicated in existing laboratory facilities. However, suitable ocean sites provide a natural set of hydrodynamic generating forces resulting from winds, waves, and variable surface and subsurface currents. TRW has established a test range leeward of the isthmus of Santa Catalina Island, off Southern California. This site was chosen to take advantage of a prevailing gyre, water depth to facilitate diving, water clarity and a sandy bottom. An instrumentation system was installed to measure wind, wave and current profile vectors. Test data are to be recorded when sea states are representative of full scale operating conditions. Platform motions and mooring system loads for several scaled OTEC platforms are to be measured optically and with load cells. The data will be recorded on digital magnetic tape and a multichannel chart recorder. (Author)

A80-53675 Kelp farm and OTEC-1 upwelling pipes. A. Person (Global Marine Development, Inc., Irvine, Calif.). In: Marine technology 79: Ocean energy, Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 21-27. A distinctly unique version of an upwelling pipe, 1400 feet long and providing 8,800 gpm flow, has been in operation for a year supplying nutrient rich bottom water to a kelp test farm moored in 1800 feet, offshore Dana Point, California. Another version of this pipe, 2100 feet long with a flow rate of 68,000 gpm has been designed to supply deep cold water to a 1 MW ocean thermal energy conversion test plant (OTEC-1). The latter pipe is currently being manufactured prior to assembly and deployment to the test platform which will be moored in 4,500 feet offshore Kawaihae, Hawaii. Both the kelp test farm and the OTEC-1 pipes are made of polyethylene. This paper presents a synopsis of the learning process that led to these designs, a summary of the more significant design results and a description of the pertinent operational results to date. (Author)

A80-53676 Wave drift forces on OTEC platforms. P. Kaplan (Hydromechanics, Inc., Plainview, N.Y.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 28-33. 13 refs.

Analytical methods to determine the mean value of the slowly-varying second order drift forces due to waves on different types of OTEC platforms (a barge form and a spar) are described. The basic method used is via free surface hydrodynamics, in terms of the radiated and scattered waves for these platforms (including the deep cold water pipe) during their interaction with incident waves.

Procedures for evaluating the mean value of the drift forces in different random seas are given, as well as a description of methods used for time domain simulation of the drift forces for application to dynamic analysis of stationkeeping system performance (either moorings or dynamic positioning thrusters) for these OTEC platforms.

(Author)

A80-53678

U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview. W. G. Sherwood (U.S. Department of Energy, Ocean Systems Branch, Washington, D.C.), W. W. Rogalski, E. A. Midboe (Gibbs and Cox, Inc., Arlington, Va.), and F. Szeto (NOAA, Office of Ocean Engineering, Rockville, Md.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979.

Washington, D.C., Marine Technology Society, 1979, p. 80-85. 6 refs.

This paper presents an overview of the approach being taken by the DOE to develop methods to extract the ocean currents and waves energy to where these methods can effectively contribute to the energy needs of the U.S. Characteristics of wave and current energy conversion systems being considered are discussed including foreign developments. Also, salient points of a systems development program plan, being developed to assess these systems for adaptation into practical energy generation systems, are presented. Such approaches as heaving bodies, cavity resonators, wave focusers and rotary and linear current energy converters are described, and the ocean engineering related problems and unknowns requiring resolution are addressed along with the projected programs designed to resolve some of these issues. (Author)

A80-53679 DAM-ATOLL - A system for extracting energy from ocean waves. T. P. Higgins (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979 Washington, D.C., Marine Technology Society, 1979, p. 86-90.

A DAM-ATOLL is a dome-shaped structure located just below the neutral level of the sea. The dome shape acts as a concentrating device to concentrate wave energy in both vertical and horizontal directions. The concentrated wave energy is directed to a central core in such a way as to create a vortex flow. The vortex in the central core serves as a fluid flywheel from which energy is gradually and continuously withdrawn by a turbine. When the turbine drives an electric generator, the nominal output of a 280-ft-diameter DAM ATOLL is of the order of 1-2 MW, depending on the input wave energy. A 1/100 scale model has been constructed and operated as a proof-of-concept.

A80-53684 The Cold Water Pipe - Ocean engineering status and developments. J. R. Roney (Ocean Engineering, Princeton, N.J.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 265-270.

Previous designs of the OTEC Cold Water Pipe were based on reinforced concrete or steel as the structural material. Many design uncertainties and complexities developed which compounded the basic difficulties of the problem, one of which was a time consuming and costly deployment. Subsequently, newer design approaches using fiberglass reinforced plastic or elastometers have emerged and appear more suitable. It is suggested that it is currently possible to lay out a stepwise detailed engineering development plan to assure a suitable.

cold water pipe; details of this plan are discussed.

A80-53686 Ocean engineering developments for OTEC 10/40 MW spar platforms. R. J. Scott (Gibbs and Cox, Inc., Arlington, Va.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 315-319.

This paper describes the conceptual design of 10 and 40 MW Offshore Thermal Energy Conversion (OTEC) spar platforms, and

defines advances in the current state-of-the-art in ocean engineering required to support their further development. 10 and 40 MW concepts are described including principal characteristics and arrangements of the platform, cold water pipe, power and energy transfer systems. Technology advances are then defined to support future design development at an acceptable level of risk. Potential high risk areas include user acceptance of the spar concept, cold water pipe fatigue and materials selection, platform safety and the electrical riser cable interface with the platform. Medium risk areas include development of design criteria acceptable to regulatory agencies, cathodic protection, deployment, modularity, and environmental considerations.

(Author)

A80-53688 Optimum OTEC design and sensitivity analysis using geometric programming. C. A. Atkinson (TRW Defense and Space Systems Group, Redondo Beach, Calif.) and S. E. Jacobsen (California, University, Los Angeles, Calif.). In: Marine technology 79: Ocean energy; Proceedings of the Fifteenth Annual Conference, New Orleans, La., October 10-12, 1979. Washington, D.C., Marine Technology Society, 1979, p. 331-339. 10 refs. NSF Grant No. ENG-76-12250.

The basic OTEC system is modeled as a geometric program. The model includes power system elements (heat exchangers, turbine/generators, and pumps) and ocean system components (platform, cold-water pipe). For a given MWe output, the model produces a minimal cost design of the OTEC system. In particular, the model determines heat exchanger tube diameters and lengths, cold water pipe diameter and length, hot and cold water and working fluid flow rates, evaporation and condensation temperatures and heat loads, and turbine work. Design analyses are performed comparing two advanced heat exchanger concepts. Sensitivity analyses provide estimates of potential system cost impact resulting from uncertainties in key modeling parameters. (Author)

A80-53870 Reflectance measurements on laser-produced plasmas at 0.26 micron. A. G. M. Maaswinkel (Max-Planck-Gesellschaft zur Förderung der Wissenschaften, Garching, West Germany). Optics Communications, vol. 33, Apr. 1980, p. 62-64. 8 refs. Research supported by the Bundesministerium für Forschung und Technologie and EURATOM.

Total and specular reflection from planar Al-targets was measured with a frequency-quadrupled (wavelength of 0.26 micron) Nd-YAG laser. The intensity on target was 4 x 10 to the 13th W/sq cm with pulse duration 20 ps. Total absorption for near normal incidence was 80%; very little dependence on intensity and pulse duration was found. By varying the polarization and angle of incidence (10-80 deg) the characteristic behavior of resonance absorption was observed. (Author)

N80-28732# Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.

COMBINED EFFECTS OF PERIODIC AND STOCHASTIC LOADS ON THE FATIGUE OF WIND TURBINE PARTS, PART 6

Andre Raab (Sikob AB) 29 Oct. 1979 60 p refs 6 Vol. (Contract SWEDBESD-5061-012)

(FFA-AU-1499-Pt-6) Avail NTIS HC A04/MF A01

Selected topics on simulation of turbulence and fatigue evaluation of wind turbines are presented. The importance of correct application of random loads and the mathematical description of nonstationary processes (general theory) are discussed. The two point cross spectra of turbulence, with regard to shear flow in the boundary layer of the Earth and to the inclination of wind gusts, is determined. The two point correlation functions of turbulence when these points are situated on rotating blades is evaluated. The discrete form of the correlation functions giving the correlation matrix and the properties of this matrix in the case of band limited processes are given. Band limited, Gaussian, multivariate random processes, having a prescribed correlation matrix, are simulated with the aid of Choleski's algorithm. The application of the described theory to the evaluation of fatigue in the case of wind turbines is shown. Author (ESA)

N80-28756# Sandia Labs., Albuquerque, N. Mex. Advanced Energy Projects Div.

COMPARISON WITH STRAIN GAGE DATA OF CENTRIFUGAL STRESSES PREDICTED BY FINITE ELEMENT ANALYSIS ON THE DOE/SANDIA 17 m DARRIEUS TURBINE

Robert A. Watson Feb. 1980 20 p refs (Contracts EY-76-C-04-0789; DE-AC04-76DP-00789) (SAND-79-1990) Avail: NTIS HC A02/MF A01

By the use of strain gages, the blade structural response to purely centrifugal loading was measured on the DOE/Sandia 17 m Darrieus rotor. The measurements obtained are compared with MARC-H nonlinear finite element stress predictions. It was necessary to include gravitational effects in the finite element model to explain certain asymmetries in the data. The model with gravitational effects shows good agreement with the data. Examination of results suggests that refinement of the model to include more structural detail in the region where the blade joins the tower would probably enhance the accuracy of the model.

N80-28859\*# National Aeronautics and Space Administration.

Lewis Research Center, Cleveland, Ohio. Energy Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 2: ANALYTICAL APPROACH Final Report

H. E. Gerlaugh, E. W. Hall, D. H. Brown, R. R. Priestley, and W. F. Knightly May 1980 106 p refs (Contract DEN3-31)

(NASA-CR-159766; DOE/NASA/0031-80-2;

GE80ET010-Vol-2) Avail: NTIS HC A06/MF A01 CSCL

The use of various advanced energy conversion systems were compared with each other and with current technology systems for their savings in fuel energy, costs, and emissions in individual plants and on a national level. The ground rules established by NASA and assumptions made by the General Electric Company in performing this cogeneration technology alternatives study are presented. The analytical methodology employed is described in detail and is illustrated with numerical examples together with a description of the computer program used in calculating over 7000 energy conversion system-industrial process applications. For Vol. 1, see N80-24797. R.E.S.

N80-28867# Naval Research Lab., Washington, D. C. Marine Technology Div.

OTEC COLD WATER PIPE DESIGN FOR PROBLEMS CAUSED BY VORTEX-EXCITED OSCILLATIONS Final Report

Owen M. Griffin 14 Mar. 1980 148 p refs Sponsored in part by NOAA

(AD-A084555; AD-E000413; NRL-MR-4157) Avail: NTIS HC A07/MF A01 CSCL 13/11

Vortex-excited oscillations of marine structures result in reduced fatigue life, large hydrodynamic forces and induced stresses, and sometimes lead to structural damage and to destructive failures. The cold water pipe of an OTEC plant is nominally a bluff, flexible cylinder with a large aspect ratio (L/D length/diameter), and is likely to be susceptible to resonant vortex-excited oscillations. The objective of this report is to survey recent results pertaining to the vortex-excited oscillations of structures in general and to consider the application of these findings to the design of the OTEC cold water pipe. Practical design calculations are given as examples throughout the various sections of the report. This report is limited in scope to the problems of vortex shedding from bluff, flexible structures in steady currents and the resulting vortex-excited oscillations. The effects of flow non-uniformities, surface roughness of the cylinder, and inclination to the incident flow are considered in addition to the case of a smooth cylinder in a uniform stream. Emphasis is placed upon design procedures, hydrodynamic coefficients applicable in practice, and the specification of structural response parameters relevant to the OTEC cold water pipe. There are important problems associated with the shedding of vortices from cylinders in waves and from the combined action of waves and currents, but these complex fluid/structure interactions are not considered in this report. GRA

N80-28910# Institute of Gas Technology, Chicago, III. ELECTROCHEMICAL PHOTOVOLTAIC CELLS, PROJECT 65021

Peter G. P. Ang and Anthony F. Sammells Oct. 1979 35 p.

(Contracts EG-77-C-01-4042; XP-9-8002-5) (DSE-4042-T8) Avail: NTIS HC A03/MF A01

The photoelectrochemical performance of single crystal MoSe2 and GaAs, polycrystalline CdSe, and cells with RbAg415 solid electrolyte were evaluated. The MoSe2 electrode exhibited very good photoresponse in electrolytes containing Br(-)/Br2 redox couple. The photopotential and photocurrent were larger in acid than in alkaline electrolyte. A power conversion efficiency of about 5% was achieved under 200 mW cucm3 xenon light illumination in the acid medium. The catalytic activity of a platinized platinum electrode toward Br(-) redox couple was also better in acid electrolyte than in alkaline electrolyte. Higher current densities were obtained in the acid medium. The NoSe2 was found to have good stability in acid and alkaline electrolytes, however, it will be necessary to protect the electrolyte against evaporation of the bromine, oxidation by air, or photodecompositions. DOE

N80-28913# Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemical Engineering.

DESIGN OF LAND BASED, FOAM OTEC PLANTS FOR **BOTTOMING CYCLES** 

A. E. Molini, C. Zener, and T. Fort, Jr. 1979 6 p refs Presented at 6th OTEC Conf., Washington, D.C., 19 Jun. 1979 Prepared in cooperation with Univ. of Puerto Rico, Mayaguez (Contract EG-77-S-02-4459)

(CONF-790631-17) Avail: NTIS HC A02/MF A01 The Foam Energy Recovery Open Cycle System (FEROCS) at a 1 MW to 10 MW scale is described. A structural design was initiated for a unit 380 ft high visualized as an inverted, vertical, reinforced concrete U tube of 36 ft I.D. and walls 11 in. thick. The structure is feasible based on present construction practices with reinforced concrete in Puerto Rico. It would cost approximately \$1.4 million and consume 3800 cu yds of concrete and 860 tons of reinforcing steel. To accelerate the demonstration of FEROCS, it is proposed to utilize artifically created temperature differences that can be readily obtained between industrial thermal effluents, for example flue gases at greater than 250 F from fossil fuel fired steam generating plants, as the heat source and ambient air as the heat sink. Results are presented of a study

N80-28920# Brookhaven National Lab., Upton, N. Y. Electrochemical Technology Group.

made conceptualizing the process using different scrubbing-

FUEL CELL APPLIED RESEARCH: ELECTROCATALYSIS AND MATERIALS Quarterly Report, 1 Jul. - 30 Sep. 1978
S. Srinivasan, H. S. Isaacs, W. E. OGrady, H. Olender, L. J.
Olmer, K. Daube, and K. V. Kordesch. Jun. 1979 30 p. refs (Contract EY-76-C-02-0016)

working fluids.

(BNL-51053) Avail: NTIS HC A03/MF A01
The electrocatalysis of the formic acid and methanol oxidation reactions at underpotentially deposited metal surfaces at 25 C was investigated. The test electrode was a smooth polycrystalline platinum disc, on which a metal Bi, Cd, Pb or TI was underpotentially deposited (UPD) by potential cycling in 1 N HClO. The organic reactant (HCOOH or CH3OH) was added to this electrolyte so that its concentration was 0.26 M. Cyclic voltammograms were recorded on the Pt (control) and on the UPD test electrodes at a sweep rate of 50 mV/sec in the potential range of 0 to 1.45 V/RHE. Overpotentials in solid electrolyte fuel cells were also studied. Alternating and direct current techniques were used to determine the impedance characteristics at the platinum-yttria stabilized zirconia interface in the regions of potentials where the oxygen evolution and reduction reactions take place.

W80-28925# Rockwell International Corp., Golden, Colo. Energy Systems Group

ALTOS-MODEL 8B WIND TURBINE GENERATOR. FAILURE

K. K. Higashi and M. J. Carr. 18 Jun. 1979 - 20 p. (Contract DE-AC04-76DP-03533)

(RFP-3035/3533/79-10) Avail: NTIS HC A02/MF A01

The failure of the Altos wind turbine generator is investigated. A brittle failure of a hub was caused by the combination of a poor quality (porous) casting and a sharp corner in a machined kevwav.

N80-28926# Rockwell International Corp., Golden, Colo. Energy Systems Group.

ALTOS-MODEL 8B WIND TURBINE GENERATOR. PERFOR-MANCE REPORT Interim Report

K. K. Higashi Jul. 1979 13 p (Contract DE-ACO4-76DP-03533)

(RFP-3033/3533/79-4) Avail: NTIS HC A02/MF A01

A wind turbine generator was tested in terms of its performance under conditions which it is likely to be subjected while in normal use. All instruments used during the testing were maintained in calibration and accordance with Rocky Flats calibration procedures.

N80-28931# Technische Hogeschool, Eindhoven (Netherlands).

Dept. of Electrical Engineering.
A PARAMETRIC STUDY OF 1000 MWe COMBINED CLOSED CYCLE MHD/SYSTEM ELECTRICAL POWER GENERATING PLANTS

A. J. Geutjes and D. Kleyn Dec. 1978 60 p refs ISBN-90-6144-091-2) (TH-78-E-91; Avail: NTIS HC A04/MF A01

A parametric study was carried out for different closed noble gas MHD cycles coupled to a direct coal-fired combustion system (and in most cases to a steam bottoming plant). For the description of the components, black-box models were used. The influence of the choice of the most important design parameters on the total system efficiency was quantified, and the performance of systems compared with different configuration. The so-called topping-cycle makes the best system with an efficiency of 52% for a base case. A parametric study was done with respect to channel properties to find an optimal system efficiency for both supersonic and subsonic channels as part of a topping-cycle. The generator properties were calculated according to a quasi one dimensional model. Author (ESA)

N80-28932# Massachusetts Inst. of Tech., Cambridge. Aeroelastic and Structures Research Lab.

MOMENTUM THEORY ANALYSIS OF UNCONVENTIONAL WIND EXTRACTION SCHEMES, PART 10

Marten T. Landahl Stockholm Aeron. Res. Inst. of Sweden 12 Oct. 1979 23 p refs .6 Vol. (Contract SWEDBESD-5061-012)

(ASRL-TR-194-2-Pt-10; FFA-AU-1499-Pt-10) Avail: NTIS HC A02/MF A01

A momentum theory analysis was carried out for idealized wind energy extraction devices under the assumption of uniform wake velocity. The wind energy extraction problem was analyzed on the basis of some simple idealized flow models which demonstrate that the 'Bertz limit' can be exceeded with the aid of some unconventional extraction schemes. However, to what extent such schemes could be realized in actual engineering designs is not discussed. It is shown that by deflecting the flow through the extractor, it is theoretically possible to extract a power per unit frontal area of the extractor which is considerably (by about a factor of two) higher than that given by the simple actuator disk model. Author (ESA)

N80-28933# Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.

SAFETY OF WIND ENERGY CONVERSION SYSTEMS (WECS): PRELIMINARY STUDY

Sigge Eggwertz, Ingemar Carlsson (LUTAB Ingenjoersbryaa AB), Anders Gustafsson, Christer Lundemo, Bjoern Montgomerie, and Sven-Erik Thor 16 Nov. 1979 136 p refs (Contract SWEDBESD-5061-101)

(FFA-HU-2126) Avail: NTIS HC A07/MF A01

A safety study to provide information on the risks inherent a Wind Energy Conversion System (WECS) to the general public in the surrounding area as well as to the operator personnel is presented. Land based large scale turbine systems with

horizontal axes situated in sparsely populated areas are considered. The study is intended to serve as a preliminary manual for safety analysis of WECS. An overall description of the system, statistical information concerning loads and strength properties of materials considered, and a discussion of geometrical tolerances are included. Formulas and procedures to be employed in the risk analysis are presented, followed by comments on acceptable risk levels. The consequences of components failures are also considered. A dynamic analysis of separating objects is performed. Critical events are listed, while safety systems, inspection, and repairs are discussed. Author (ESA)

N80-29342# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

CERAMICS FOR TURBINE ENGINE APPLICATIONS

Mar. 1980 353 p refs In ENGLISH; partly in FRENCH Presented at the 49th Meeting of the AGARD Struct, and Mater. Panel,. Cologne, 8-10 Oct. 1979

(AGARD-CP-276; ISBN-92-835-0261-2) HC A16/MF A01

Advances in high temperature materials technology and/or the design and fabrication approaches to use them to increase the performance or durability, or to reduce the cost of turbine engines are assessed. One specific approach investigated involves high temperature ceramics and the associated design technology for using brittle materials in automobile engines and electric power generators. The design, fabrication, and testing of actual components are reported and the results are evaluated for aerospace applications.

N80-29345# Noel Penny Turbines Ltd., Toli Bar End (England). Engineering Analysis Dept.

REQUIREMENTS FOR MATERIALS FOR LAND VEHICLE GAS TURBINES

D. F. Moss In AGARD Ceram. for Turbine Eng. Appl. Mar. 1980 11 p refs Avail: NTIS HC A16/MF A01

The requirements for land-vehicle power plants are discussed. It is shown how engine concepts and working cycles are being developed, and how improvements in materials will contribute to making the gas turbine a major competitor in this field.

#### N80-29387 ISRO Satellite Centre, Peenya, Bangalore (India). THE POWER SYSTEM

S. Y. Ramakrishnan, R. S. Mathur, M. Subramanian, T. Kanthimathinathan, Sudarshan Jarpangal, S. T. Venkataramanan, and N. I. Savalgi *In* Indian Acad. of Sci. The Aryabhata Proj. 1979 p 29-40

Avail: Issuing Activity The power system for Aryabhata satellite is described in detail. The Aryabhata power system consists of solar panels using n/p radiation protected silicon cells, a Ni-Cd storage battery, a solar array voltage limiter, a power control unit which functions as a battery controller, power conditioning regulators, converters, and protective devices which serve mainly as load interface units. The in-orbit performance of the power system is dealt with, highlighting the probable reasons for the failure of one of the bus-lines of the power system. M:G

N80-29620 Stanford Univ., Calif.

JOULE HEATING EFFECTS IN THE ELECTRODE WALL BOUNDARY LAYER OF MHD GENERATORS Ph.D. Thesis Richard Kent James 1980 209 p Avail: Univ. Microfilms Order No. 8016835

Two models were examined that are suitable for large scale magnetohydrodynamic (MHD) generator calculations. The first model was an integral model using 1/7th power profiles and accounted in an approximate manner for electron nonequilibrium and for the effects of near wall Joule heating. The second model was a full two dimensional boundary layer model, including

solution of the electron continuity equation. Comparisons of predictions between the two models generally showed good agreement. Measurements were performed of temperature and electron number density profiles on a laboratory scale MHD generator. Comparisons between calculations from the two dimensional theory and measurments for cases without current generally showed good agreement when the turbulence model properly accounted for effects of free stream turbulence. Measurements of electron number density profiles indicated that some degree of nonequilibrium existed near the wall, but the effect was small. Dissert. Abstr.

N80-29738# Air Force Wright Aeronautical Labs., Wright-Patterson AFB. Ohio.

A REVIEW OF ADVANCED VEHICULAR DIESEL RESEARCH AND DEVELOPMENT PROGRAMS WHICH HAVE POTEN-TIAL APPLICATION TO STATIONARY DIESEL POWER PLANTS Final Report, 1 Mar. - 1 Dec. 1979

Andrew W. Kaupert Wright Patterson AFB, Ohio AFWAL Mar. 1980 83 p refs (AF Proj. 3145)

(AD-A085601; AFWAL/PO-79-036; AFWAL-TR-80-2014) Avail: NTIS HC A05/MF A01 CSCL 10/2

This report, prepared for the Aerospace Power Division, Aero Propulsion Laboratory, Wright-Patterson AFB, reviews, assesses, and summarizes the research and development status of advanced diesel engine/vehicular component technologies, and identifies those systems which may have application to diesel power plants utilized as stationary engine power sources.

N80-29741# Barnes and Reinecke, Inc., Elk Grove, III. STEAM ENGINE ANALYSIS Final Technical Report William G. Allbach, Merle J. Smith, and Robert F. Wenshutonis Jun. 1979 141 p (Contract ET-77-C-01-8917)

(FE-8917-2) Avail: NTIS HC A07/MF A01 Familiarization, cost, and thermodynamic analysis were made of a prototype Rankine cycle steam engine intended for application in an underground vehicle. The cost analysis was made, by direction, for the material and direct labor based on a single prototype steam engine extended to lots of 100 units and 500 units annually. The conclusions derived from the familiarization and the cost analysis are that the cost is higher than alternate vehicle power systems, the design and configuration is not in a state of reproductibility and maintainability, and must be reconfigured for cost reduction. The thermodynamic analysis of the effect of the steam power plant upon the mine environment indicates that the steady state temperature in the mine entry air downstream of the steam powered vehicle would increase significantly while the steam engine is operating, unless the ventilation air flowrate is increased above the minimum 9000 CFM requirement.

#### N80-29844# National Aeronautical Lab., Bangalore (India). A HORIZONTAL AXIS SAIL WINDMILL FOR USE IN IRRIGATION

S. K. Tewari, Ningaiah, D. V. V. Subramanyam, and A. C. Samraj Mar. 1979 22 p refs

(NAL-TN-54) Avail: NTIS HC A02/MF A01

Some basic considerations in the design and development of a horizontal axis windmill, intended primarily for irrigation in small farms from shallow open wells are described. This windmill has six triangular sails sweeping a circle of 10 meters in diameter, and is an adaptation from Greek sail windmills. For the construction of this windmill, all efforts are made to use materials and parts readily available in the hardware market except for the gear boxes. The cost of material and parts is approximately \$900 which excludes cost of machining and fabrication charges. Preliminary performance tests indiate a pumping rate of 6000 to 11,000 liters/hour over a head of 6.85 meters in wind speeds of 10 to 16 km/hr.

N80-29862\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio. RAPPORTEUR REPORT: MHD ELECTRIC POWER **PLANTS** 

George R. Seikel 1980 17 p Presented at 7th Intern. Conf. on MHD Elec. Power Generation, Cambridge, Mass. 16-20 Jun.

(Contract EF-77-A-01-2674)

(NASA-TM-81554; DOE/NASA/2674-12; E-516) Avail: NTIS HC A02/MF A01 CSCL 10B

Five US papers from the Proceedings of the Seventh International Conference on MHD Electrical Power Generation at the Massachusetts Institute of Technology are summarized. Results of the initial parametric phase of the US effort on the study of potential early commercial MHD plants are reported and aspects of the smaller commercial prototype plant termed the Engineering Test Facility are discussed. The alternative of using a disk geometry generator rather than a linear generator in baseload MHD plants is examined. Closed-cycle as well as open-cycle MHD plants are considered.

N80-29885# Brookhaven National Lab., Upton, N. Y. Electrochemical Technology Group.

FUEL CELL APPLIED RESEARCH: ELECTROCATALYSIS AND MATERIALS Quarterly Report, 1 Oct. - 31 Dec. 1978 S. Srinivasan, H. S. Isaacs, J. McBreen, W. E. Ogrady, H. Olender, L. J. Olmer, E. J. Taylor, C. Y. Yang, and G. P. Wirtz Jul. 1979 36 p refs (Contract EY-76-C-02-0016)

(BNL-51072) Avail: NTIS HC A03/MF A01

Investigations were carried out on the sintering of carbon supported platinum catalysts in phosphoric acid at 150 C over a 3500 hour period. The most significant result was that the sintering rate was five times slower for these electrodes as compared with unsupported platinum electrodes. After aging the electrodes for 1200 h, attempts were made to regenerate the active areas of one of the electrodes by cycling at 100 V/s in various voltage envelopes between -0.1 V and 1.1 V. These treatments were unsuccessful for regeneration of the activity. A ring-disc electrode investigation of oxygen reduction in 85 percent phosphoric acid was carried out. Work included determination of the Tafel parameters, oxygen diffusivity, reaction order, and the extent of peroxide formation. Also, solid electrolyte fuel cells were studied. A cell was designed and fabricated for measurement of oxygen diffusion in interconnection materials. Both transient and steady methods are being used and diffusivity as well as concentration of diffusing species can be obtained. The cell is being calibrated by measuring oxygen diffusion in nickel foils of various thickness. Oxygen ion transport in In2O3, an oxygen electrode material, was also investigated using the oxide as a membrane, but leakage at the edges of cells prevented direct measurements. DOE

N80-29891# Midwest Research Inst., Golden, Colo. Energy Research Inst.

SCREENING METHOD FOR WIND ENERGY CONVERSION

Robert D. McConnell Mar. 1980 6 p refs Presented at Am. Sect. of the Intern. Solar Energy Soc. Conf., Phoenix, Ariz., 2-6 Jun. 1980

(Contract EG-77-C-01-4042)

(SERI/TP-731-649; CONF-800604-19) NTIS

HC A02/MF A01

A screening method is presented for evaluating wind energy conversion systems (WECS) logically and consistently. It is a set of procedures supported by a data base for large conventional WECS. The procedures are flexible enough to accommodate concepts lacking cost and engineering detail, as is the case with many innovative wind energy conversion systems (IWECS) The method uses both value indicators and simplified cost estimating procedures. Value indicators are selected ratios of engineering parameters involving energy, mass, area, and power. Cost mass ratios and cost estimating relationships were determined from the conventional WECS data base to estimate or verify installation cost estimates for IWECS. These value indicators and cost estimating procedures are shown for conventional WECS. An application of the method to a tracked vehicle airfoil concept is presented.

N80-29922# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.

ADVANCED COMBUSTION SYSTEMS FOR STATIONARY GAS TURBINE ENGINES. VOLUME 2: BENCH SCALE EVALUATION Final Report, Sep. 1976 - Jan. 1978

Robert M. Pierce, Stanley A. Mosier, Clifford E. Smith, and B. S. Hinton Jan. 1980 384 p ref 2 Vol.

(Contract EPA-68-02-2136)

(PB80-175607; FR-11405-Vol-2; EPA-600/7-80-017B-Vol-2)

Avail: NTIS NC A16/MF A01 CSCL 13B

Results from the testing program identified two design approaches capable of significant emission reduction. A staged centertube design, relying on burner operation near the lean blowout limit, gave low NOx and CO emissions on clean no. 2 fuel oil, but was ineffective for fuels containing bound nitrogen. A rich-burn/quick-quench (RB/QQ) design, producing a fuel-rich primary zone and quickly quenching the effluent from that region to the high overall excess air conditions required by the gas turbine cycle, successfully controls NOx from both thermal and fuel-bound sources while maintaining low CO emissions for high thermal efficiency. The RB/QQ concept was selected for scaleup to full size hardware.

N80-30198# Technische Hogeschool, Eindhoven (Netherlands).

Dept. of Electrical Engineering.
THE DISPERSION RELATION OF ELECTROTHERMAL WAVES IN A NONEQUILIBRIUM MAGNETOHYDRO-DYNAMIC PLASMA

P. Massee Dec. 1978 27 p refs

(TH-78-E-92; ISBN-90-6144-092-0)

NTIS

HC A03/MF A01

The experimental verification of the dispersion relation for electrothermal waves is described. The theoretical derivation of this relation as presented differs from the usual approach as the experiment requires an analysis in terms of real frequency and complex wave number. In the experiment, values for electron temperature of up to 2400 K and for electron density of up to 700 exa/cu cm were realized. The properties of the heavy particle gas were not characteristic for the situation in a closed cycle magnetohydrodynamic generator since electrothermal waves are essentially a property of the electron gas only. Hence, the waves were excited artificially in the stable regime so that they were damped, which set high requirements on the measuring technique. The ratio of the amplitudes at two successive double probes was measured as well as the phase shift between the two signals. Experimental results which are discussed and compared with theoretical predictions, show reasonably good agreement for the ratio of amplitides. However, measurements of the phase shift show little agreement with theoretical predictions, a fact for which no explanation can be given. Author (ESA)

N80-30755# General Electric Co., Philadelphia, Pa. Forge Space Center.

DESIGN AND DEVELOPMENT OF STIRLING ENGINES FOR STATIONARY POWER APPLICATIONS IN THE 500 TO 3000 HP RANGE. SUBTASK 1A REPORT: STATE-OF-THE-ART CONCEPTUAL DESIGN

1 Mar. 1980 363 p (Contract DE-AC02-79ET-15209)

(DOE/ET-15209-T1) Avail: NTIS HC A16/MF A01

Reliable cost data for a stationary Stirling engine capable of meeting future needs for total energy/cogeneration systems were obtained and a pragmatic and conservative base design for a first generation hardware was established. Four engine types, V-type crank engine, radial engine, swashhplate engine, and rhombic drive engine, and three heat transport systems, heat pipe, pressurized gas heat transport loop, and direct gas fired system, were selected. After a preliminary layout cycle, the rhombic drive engine was eliminated due to intolerable maintenance difficulties on the push rod seals. The V, radial and swashplate engines were taken through a detailed design/layout cycle, to establish all important design features and reliable engine weights. After comparing engine layouts and analyzing qualitative and quantitative evaluation criteria, the V-crank engine was chosen as the candidate for a 1985 hardware demonstration.

N80-30757# Biphase Energy Systems, Inc., Santa Monica, Calif. DESIGN STUDY OF A TWO-PHASE TURBINE BOTTOMING CYCLE Final Report

Walter R. Studhalter 15 Jun. 1979 123 p refs (Contract EY-76-C-03-1207)

(DOE/ET-15350-T1) Avail: NTIS HC A06/MF A01

The use of a biphase turbine system to recover waste heat from diesel engines was examined and found to have many favorable attributes. Among these were low rpm, high torque, low heat exchanger cost, and simplicity. Several candidate working fluid combinations were tested at temperatures of interest. The contact heat exchanger concept was substantiated by large scale experiment. The program includes subscale tests of key hardware components of a biphase turbine bottoming system. These are the two-phase nozzle, two-phase turbine, and direct contact heat exchanger. A comprehensive cost analysis was completed. A three-year program leading to a full-size system field demonstration is planned. Progress in the first year of this program and the effort started on the second year program are reported.

N80-30886 Drexel Univ., Philadelphia, Pa. INDUSTRIAL APPLICATION AND ASSESSMENT OF WASTE ENERGY RECOVERY TECHNOLOGIES Ph.D. Thesis Michael John Koluch 1980 319 p

Avail: Univ. Microfilms Order No. 8019349

Nine generic waste energy recovery technologies were examined for potential applications in industry. These were heat exchangers, Rankine power cycles, Brayton power cycles, Stirling power cycles, heat pumps, absorption cooling systems, expanders, burner, and cogeneration systems. Several industries were examined. A methodology was developed to assess waste energy recovery technologies. It comprises an industry waste flow/technology compatibility prescreen computer model, prescreen evaluation, specific technology application computer model and technology application assessment. Technology limitations were incorporated into a computer model to prescreen potential applications in 87 industrial processes. Results of that prescreen indicated that heat exchangers, heat pumps, Rankine cycles and cogeneration systems ranked highest in the utilization of waste streams. Numerous specific waste stream, technology, end use applications were examined in detail. Performance technology models were used to simulate applications.

N80-30888\*# General Electric Co., Fairfield, Conn. Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA: PART 1: COAL-FIRED NOCOGENERATION PROCESS BOILER, SECTION A Final Report

W. F. Knightly May 1980 469 p

(Contract DEN3-31)

(NASA-CR-159770-Pt-1-A; DOE/NASA/0031-80/6-Vol-6-Pt-1A; GE80ET0105-Vol-6-Pt-1A) Avail: NTIS HC A20/MF A01 CSCL 10B

About fifty industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines. and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on site gasification of coal. Computer generated reports of the fuels consumption and savings, capital costs, economics and emissions of the cogeneration energy conversion systems (ECS's) heat and power matched to the individual industrial processes are presented. National fuel and emissions savings are also reported for each ECS assuming it alone is implemented. Two nocogeneration base cases are included: coal fired and residual fired process boilers.

N80-30889\*# General Electric Co., Fairfield, Conn. Energy Technology Operation. COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA. PART 1: COAL-FIRED NOCOGENERATION PROCESS BOILER. SECTION B Final Report

W. F. Knightly May 1980 480 p

(Contract DEN3-31)

(NASA-CR-159770-Pt-1-B;

DOE/NASA/0031-80/6-Vol-6-Pt-1B;

GE80ET0105-Vol-6-Pt-1B) Avail: NTIS HC A21/MF A01 CSCL 10B

About fifty industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on site gasification of coal. Computer generated reports of the fuel consumption and savings, capital costs, economics and emissions of the cogeneration energy conversion systems (ECS's) heat and power matched to the individual industrial processes are presented. National fuel and emissions savings are also reported for each ECS assuming it alone is implemented. Two nocogeneration base cases are included: coal fired and residual fired process boilers.

N80-30890\*# General Electric Co., Fairfield, Conn. Technology Operation.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 6: COMPUTER DATA. PART 2: RESIDUAL-FIRED NOCOGENERATION PROCESS BOILER Final Report

W. F. Knightly May 1980 296 p

(Contract DEN3-31)

(NASA-CR-159770-Pt-2; DOE/NASA/0031-80/6-Vol-6-Pt-2; GE80ET0105-Vol-6-Pt-2) Avail: NTIS HC A13/MF A01 CSCL

About fifty industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on site gasification of coal. Computer generated reports of the fuel consumption and savings, capital costs, economics and emissions of the cogeneration energy conversion systems (ECS's) heat and power matched to the individual industrial processes are presented. National fuel and emissions savings are also reported for each ECS assuming it alone is implemented. Two nocogeneration base cases are included: coal fired and residual fired process boilers.

N80-30902# Prototech, Inc., Newton Highlands, Mass.
ENERGY SAVINGS BY MEANS OF FUEL CELL ELECTRODES IN ELECTRO-CHEMICAL INDUSTRIES Annual Report, 1 Aug. 1978 - 31 Jul. 1979

Robert J. Allen, Walter Juda, Robert W. Lindstrom, and Henry G. Petrow 31 Oct. 1980 200 p refs

(Contract ET-78-C-02-4881)

(COO-4881-12) Avail: NTIS HC A10/MF A01

Energy and cost savings in electrowinning of zinc by substituting, for the conventional lead anode, a Prototech proprietary hydrogen anode operating on pure and impure feeds were evaluated experimentally along with voltage; and thus energy savings in chloralkali membrane cells by substituting, for the conventional steel cathode, a Prototech proprietary air cathode. Suitable air electrodes for metal/water/air batteries were considered. Cost estimates of all processes investigated based on laboratory results were prepared. DOE

N80-30905# Energy Research Corp., Danbury, Conn. AQUEOUS TRIFLUOROMETHANESULFONIC ACID FUEL CELLS Interim Technical Report, Jun. 1978 - Aug. 1979 Michael George Dec. 1979 47 p refs (Contract DAAK70-78-C-0103) (AD-A086579; ERC-6154-I) Avail: NTIS HC A03/MF A01

CSCL 10/2

Subscale hydrogen-air fuel cells were successfully operated with 6M TFMSA as the electrolyte at temperatures as high as 60 C. The fuel cell performance was enhanced over similarly loaded electrodes in H3PO4 due to the apparent improved kinetics for the oxygen reduction reaction. A variety of unsupported and supported Pt electrocatalysts could be effectively utilized. TFMSA fuel cells could be operated stably for periods as long as 3000 hours if water balance was maintained. Activity coefficients calculated by the van Laar equations were utilized to predict water partial pressures of dilute TFMSA solutions. GRA

N80-30907# Rockwell International Corp., Golden, Colo. Energy Systems Group.

ROCKY FLATS SMALL WIND SYSTEMS TEST CENTER ACTIVITIES. VOLUME 1: ATMOSPHERIC TEST DATA COLLECTED FROM SMALL WIND ENERGY CONVERSION SYSTEMS Interim Report, 1 Jul. 1978 - 30 Jun. 1979

Jul. 1979 122 p 2 Vol. (Contracts EY-76-C-04-3533; DE-AC04-76DP-03533) (RFP-3004-Vol-1; IR-2-Vol-1) Avail: NTIS HC A06/MF A01

The wind system data of various tests of small wind energy conversion system (SWECS) are presented. Much of the data are not final, but are believed to present an accurate representation of the performance of each system. Because of operating problems and failures experienced by some of the machines (and at times by the data collection system) the amount of data available for analysis varies widely from system to system. Data are presented on a total of 16 machines, including updated data on nine machines which were presented in the first semiannual report. Vibration, controlled velocity testing and plans for a dynamometer test facility (which is under construction) are described. The description of each system under test includes information on design output, output type, rotor configuration, and other basic design features. The condition under which each SWECS was tested are described. Graphic plots of quantitative data and narrative accounts of qualitative data collected on each SWECS are provided.

N80-30908# Rockwell International Corp., Golden, Colo. Energy Systems Group.

ROCKY FLATS SMALL WIND SYSTEMS TEST CENTER ACTIVITIES. VOLUME 2: CONTROLLED VELOCITY, VIBRATION AND DYNAMOMETER TESTING OF SMALL WIND ENERGY CONVERSION SYSTEMS Interim Report Jul. 1979 44 p 2 Vol.

(Contracts EY-76-C-04-3533; DE-AC04-76DP-03533)

(RFP-3004-Vol-2; IR-2-Vol-2) Avail: NTIS HC A03/MF A01

Controlled velocity, vibration, and dynamometer testing performed on small wind energy conversion systems are discussed. Results of controlled velocity testing on wind machines and of vibration testing of five wind machines are included. DOE

N80-30928# Lincoln Lab., Mass. Inst. of Tech., Lexington. SYSTEM DESIGN, TESTS RESULTS, AND ECONOMIC ANALYSIS OF A FLYWHEEL ENERGY STORAGE AND CONVERSION SYSTEM FOR PHOTOVOLTAIC APPLICA-TIONS

A. R. Millner and T. Dinwoodie 1980 7 p Presented at the 14th Photovoltaics Specialists Conf., San Diego, Calif., 7 Jan. 1980 Prepared in cooperation with MIT, Cambridge, Mass. (Contract EY-76-C-02-4094)

(COO-4094-70: CONF-800106-18) NTIS Avail: HC A02/MF A01

The development of a flywheel interface and storage system for use with photovoltaic power sources is discussed. Test data on the performance of components built to investigate the feasibility of such a system, and the results of economic studies of the system showing user-worth analysis and manufacturing-cost estimates, are presented. The system has magnetic bearings, a maximum-power-point tracker, dc input, and

cycloconverter output from an ironless-armature motor-DOE generator.

N80-30930# Westinghouse Electric Corp., East Pittsburgh, Pa. Advanced Systems Technology Dept.

DESIGN STUDY AND ECONOMIC ASSESSMENT OF MULTI-UNIT OFFSHORE WIND ENERGY CONVERSION SYSTEMS APPLICATION. VOLUME 1: EXECUTIVE SUMMARY Final Report

L. A. Kilar 14 Jun. 1979 59 p (Contract EX-76-C-01-2330)

(WASH-2330-78/4-Vol-1) Avail: NTIS HC A04/MF A01

Offshore wind energy conversion system design, both deep and shallow water, are evaluated. The costs of building offshore platforms and underwater cables for power transmission are discussed. Maps show the U.S. ocean areas most suitable for optimum results.

N80-30931# Rockwell International Corp., Golden, Colo. Rocky Flats Plant.

SENCENBAUGH: MODEL 1000-14 WIND TURBINE GENERATOR Performance Report

K. K. Higashi Jul. 1979 13 p (Contract DE-AC04-76DP-03533)

(RFP-3034/3533/79-5) Avail: NTIS HC A02/MF A01

Data are provided which give an accurate picture of the performance of the Sencenbaugh Model 1000-14 under conditions approximating normal use. Every effort was made to ensure that the data provided are accurate and the calibration of all instruments was continuously maintained. The tests were designed to develop a power curve for a known load (application) and determine the ability of the machine to survive high winds (85 mph or greater). The Sencenbaugh was tested under a variety of tail assembly adjustment modes. In none of the tests did the test data match the manufacturer's performance curve; however, changing the tail orientation resulted in proved performance. The model tested is no longer in production, and was replaced by a model with a redesigned tail assembly. L.F.M.

N80-30933# Sandia Labs., Albuquerque, N. Mex. PERFORMANCE DATA FOR A LITHIUM-SILICON/IRON DISULFIDE, LONG-LIFE, PRIMARY THERMAL BATTERY Rod K. Quinn, Arlen R. Baldwin, and James R. Armito 1980 18 p refs Presented at the 24th Power Sources Conf., Atlantic City, 9 Jun. 1980

NTIS

(Contract EY-76-C-04-0789)

(SAND-79-2148C; CONF-800612-3)

HC A03/MF A01

The effects of various environmental tests on battery performance are reported. In order to simulate possible nuclear ordnance environments, batteries were subjected to shock, rhythmic and random vibration, and longitudinal and lateral acceleration in the unactivated and activated state. The level and duration of these tests varied, but the performance remained good. The effects of variation in current density from open circuit to 1 A/sq cm as well as various pulse loads were examined. Also presented are results of stabilizing the batteries at temperatures in the range of -54 C to +70 C as reflected in various performance parameters. The Li(Si)/LiCI.KCI/FeS2 electrochemical system was also applied to two new Sandia designed batteries requiring rugged, medium life performance, i.e., activated lives of 2.5 and 4 minutes. Encouraging initial results of this application are included here. DOE

N80-30934# TRW Energy Systems, Redondo Beach, Calif. FEASIBILITY STUDY FOR INDUSTRIAL COGENERATION **FUEL CELL APPLICATION** 

15 Nov. 1979 67 p refs (Contract ET-78-C-03-1889)

(SAN-1889-T1) Avail: NTIS HC A04/MF A01

A study of the feasibility of using a first generation, phosphoric acid fuel cell as a cogenerating, total energy system for aluminum processing is presented. The objectives of the study were to: (1) determine the technical, institutional, and economic factors which would make the first generation fuel cell attractive; (2) identify modifications of fuel cell technology which would enhance fuel cell attractiveness in an industrial climate; and (3) define institutional and economic changes which might enhance fuel cell attractiveness. The study incorporated a number of tasks, involving site selection, thermal and electrical load characterization, definition of fuel cell fuel supply options. evaluation of environmental impacts, and consideration of ownership options.

N80-30937# Brookhaven National Lab., Upton, N. Y. Electrochemical Technology Group.

#### FUEL CELLS FOR ELECTRIC UTILITY AND TRANSPORTA-TION APPLICATIONS

S. Srinivasan 1980 30 p refs Presented at the Seminar on Electrochem. Systems: Batteries and Fuel Cells, Fortaleza-Ceara. Brazil, 2 Mar. 1980

(Contract EY-76-C-02-0016)

CONF-800324-2) (BNL-27452:

NTIS Avail.

HC A03/MF A01

The status of fuel cell development is reviewed. For terrestrial electric utility applications, the most promising are phosphoric acid, molten carbonate and solid electrolyte fuel cells. The first will be coupled with a reformer (to convert natural gas, petroleum derived and biomass fuels to hydrogen) while the second and third with a coal gasifier. As ground transportation power sources, the promising systems are phosphoric (or alternate acid) and alkaline electrolyte fuel cells. In the first case, methanol is most attractive while in the second, it will be hydrogen stored as a compressed gas or as a hydride. A technoeconomic assessment of a 'Regenerative Hydrogen-Halogen Energy Storage System' demonstrates the prospects of its use for load leveling when coupled with nuclear, solar or wind power plants.

#### N80-30941# Battelle Pacific Northwest Labs., Richland, Wash. SITING HANDBOOK FOR SMALL WIND ENERGY CONVER-SION SYSTEMS

Harry L. Wegley, James V. Ramsdell, Montie M. Orgill, and Ron L. Drake Mar. 1980 90 p refs

(Contracts EY-76-C-06-1830; DE-AC06-76RL-01830)

(PNL-2521-Rev-1) Avail: NTIS HC A05/MF A01 A siting guide for small wind energy conversion systems

having a rated capacity of less than 100 kilowatts is presented. Meteorological, geographical, and wind data collection considerations are discussed. By properly using the siting techniques, an owner can select a site that will yield the most power at the least installation cost, the least maintenance cost, and the least risk of damage or accidental injury.

N80-30943# Rockwell International Corp., Golden, Colo. Energy Systems Group.

SMALL WIND TURBINE SYSTEMS 1979: A WORKSHOP ON R AND D REQUIREMENTS AND UTILITY INTERFACE/ INSTITUTIONAL ISSUES. VOLUME 1: R AND D REQUIREMENTS

Darrell M. Doge, ed. and Joel V. Stafford, ed. 1979 299 p refs Conf. held at Boulder, Colo., 27 Feb. - 1 Mar. 1979 (Contract EY-76-C-04-3533)

(RFP-3014-Vol-1) Avail: NTIS HC A13/MF A01

Current wind turbine design efforts to reduce the cost of energy to a minimum, and still provide a safe and reliable turbine system are discussed. The major thrust of any supporting research and technology development program should be directed toward this same goal. The factors which contribute to the cost of energy, and which can possibly be improved by research and development are analyzed. DOF

N80-30948# Stuttgart Univ. (West Germany). Inst. fuer Statik

STATIC INVESTIGATION OF ROTOR BLADES AT REST AND UNDER QUASI-STATIONARY LOADING STATISCHE UNTERSUCHUNG VON ROTORBLAETTERN UNTER EIGENGEWICHT UND IM STATIONAEREN BETRIEB]

J. H. Argyris, K. A. Braun, and B. Kirchgaessner 1979 57 p refs In GERMAN; ENGLISH summary Prepared in cooperation with Bundesministerium fuer Forschung und Technologie, Bonn (West Germany)

The rotor blades of a horizontal axis wind energy converter which have flap and lead-lag freedom as well as a flap-pitch coupling, were dimensioned and studied under both nonoperating deadweight and quasi-stationary loading at constant forces rated operation. With a suitable mass distribution it is possible to drastically reduce the blade bending moments in the flap direction. Materials well known in aircraft construction were

(ISD-243; ISSN-0170-6071) Avail: NTIS HC A04/MF A01-

considered, among which carbon fiber reinforced plastic is shown to be the most suitable. Most of the blade models were investigated without a lead-lag hinge. Conical oscillation at rated operation was assumed for the layout of these rotor blades. It is reduced considerable for the same blade models when lead-lag freedom is incorporated while maintaining sufficient centrifugal stiffness in the lag direction.

N80-30949# Stuttgart Univ. (West Germany). Inst. fuer Statik und Dynamik

STABILITY AND DYNAMIC RESPONSE TO GRAVITA-TIONAL FORCES OF THE FLAPPING AND LEAD-LAG HINGES ON A RIGID ROTOR BLADE WITH THE LEADING-EDGE ANGLE OF ATTACK AND FLAPPING BEING COUPLED [STABILITAET UND SCHWERKRAFTRESPONSE DER SCHLAG-SCHWENKBEWEGUNG EINES STARREN ROTORBLATTES MIT BLATTWINKELRUECKSTEUERUNG] J. H. Argyris and B. Kirchgaessner 1979 53 p refs In

GERMAN: ENGLISH summary Prepared in cooperation with Bundesministerium fuer Forschung und Technologie, Bonn (West Germany)

(ISD-244; ISSN-0170-6071) Avail: NTIS HC A04/MF A01 The coupled flapping and lead-lag motion of a single, rigid rotor blade of a wind energy converter with flapping and lead-lag hinges as well as a coupling of the angle of attack with the flapping motion is investigated. The equations of motion are developed under the assumption of linearized quasi-stationary aerodynamic forces. Static and dynamic stability of the coupled flapping and lead-lag motion are investigated. The equations are integrated for different cases under cyclic gravitational forces to get an estimate of the influence of force terms and of the error from the linearization of the conservation expressions.

Author (ESA)

N80-30950# Stuttgart Univ. (West Germany). Inst. fuer Statik und Dynamik.

DYNAMIC ANALYSIS OF A ROTOR BLADE WITH LEAD-LAG FREEDOM, FLAPPING FREEDOM, AND VARIABLE-CONTROLLED BLADE PITCH ANGLE [DYNAMISCHE ANALYSE EINES ROTORBLATTES MIT SCHLAGFREIHEIT, SCHWENKREIHEIT UND TWINKERLUECKSTEUERUNG!

J. H. Argyris, K. A. Braun, and B. Kirchgaessner 1979 95 p refs In GERMAN: ENGLISH summary Prepared in cooperation with Bundesministerium fuer Forschung und Technologie, Bonn (West Germany)

(ISD-258; ISSN-0170-6071) Avail: NTIS HC A05/MF A01 The dynamic behavior of the rotor blades of a wind energy converter with flapping and lead-lag hinges as well as coupling of flapping and blade pitch is investigated. Under the assumption of rigid support of the hub and of constant rotational speed, a linearized system of differential equations of motion is developed using finite element idealization given linearized quasi-stationary aerodynamic forces. For two rotor blade models, which differ only in their stiffness in the lead-lag direction, the complex eigenfrequencies are calculated. Further, the dynamic response of the rotor blades in computed for cyclic gravity loads at rated operation, for a gust, and for the case of tower wake. From the deformation of the structure the stresses at selected points along the blade are derived, while for one version of the rotor blade, torque and rotor thrust are also determined. Author (ESA)

N80-30953# National Technical Information Service, Springfield,

THERMIONIC ENERGY CONVERSION. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1977 - May 1980 William E. Reed Jun. 1980 135 p Supersedes NTIS/PS-79/. 0596; NTIS/PS-78/0591

(PB80-810906; NTIS/PS-79/0596; NTIS/PS-78/0591)
Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B
Research on thermionic power generation, power plant design, converter design, and basic research on thermionic materials are cited. Spacecraft applications are included. This updated bibliography contains 129 abstracts, 23 of which are new entries to the previous edition.

GRA

N80-30954# National Technical Information Service, Springfield,

## MAGNETOHYDRODYNAMIC GENERATORS IN POWER GENERATION. CITATIONS FROM THE NTIS DATA BASE Progress Report. 1984 - May 1980

Progress Report, 1964 - May 1980
William E. Reed Jun. 1980 278 p Supersedes NTIS/PS-79/
0608: NTIS/PS-78/0528

(PB80-810856; NTIS/PS-79/0608; NTIS/PS-78/0578) Copyright: Avail: NTIS' HC \$30.00/MF \$30.00 CSCL 10B

The citations include research on performance, costs, efficiency, and design of MHD generators and their use in fusion and fission reactors, and fossil fueled plants. This updated bibliography contains 272 abstracts, 40 of which are new entries to the previous edition.

N80-30956# National Bureau of Standards, Washington, D.C. National Measurement Lab.

### MATERIALS FOR FUEL CELLS Annual Report, Jan. -- Dec. 1978

L. H. Bennett, C. K. Chiang, M. I. Cohen, A. L. Dragoo, A. D. Franklin, and A. J. McAlister Mar. 1980 89 p refs (PB80-182355; NBSIR-80-1991) Avail: NTIS HC A05/MF A01 CSCL 10B

The Materials for Fuel Cells Program at NBS during this year consisted of three major elements which taken together reinforce each other in techniques and concepts; these elements embrace: (1) electrocatalysis, especially hydrogen oxidation, on non noble metals and alloys; (2) degradation mechanisms involving solid oxygen-transporting electrolytes; and (3) development of instruments.

N80-30956# National Technical Information Service, Springfield, Va.

#### WIND POWER. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1977 - 1978

Audrey S. Hundemann Jun. 1980 263 p

(PB80-811433) Copyright. Avail:

HC \$30.00/MF \$30.00 CSCL 10B

The feasibility, use, and engineering aspects of wind power and windmills are discussed in these citations of Federally funded research reports. Abstracts primarily cover the use of wind power for electric power generation and wind turbine design and performance. General studies dealing with comparative analyses of wind power and alternative energy sources are included, as are energy storage devices which can be used in these systems. This updated bibliography contains 253 abstracts, none of which are new entries to the previous edition.

N80-30957# National Technical Information Service, Springfield, Va.

## WIND POWER. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1978 - May 1980

Audrey S. Hundemann Jun. 1980 305 p Supersedes NTIS/PS-79/0536: NTIS/PS-78/0417

(PB8Ö-811441; NTIS/PS-79/0536; NTIS/PS-78/0417) Copyright. Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10B

Windmill and wind power feasibility, use, and engineering are discussed in these citations of worldwide research. Abstracts primarily cover the use of wind power for electric power generator and wind turbine design and performance. General studies dealing with the use of wind power in developing countries and comparative analyses of wind power and alternative energy sources are included, as are studies on energy storage systems. This updated bibliography contains 299 abstracts, 174 of which are new entries to the previous edition.

N80-31214# Department of Energy, Washington, D. C. ASSESSMENT OF THE US MIRROR FUSION PROGRAM.

REPORT OF THE 1980 MIRROR SENIOR REVIEW PANEL Apr. 1980  $36\ p$ 

(DOE/ER-0057) Avail: NTIS HC A03/MF A01

Progress in the magnetic confinement of high temperature plasmas for the release of fusion energy is reported. Emphasis is placed on the development of the tandem mirror concept, and its incorporation into the single cell mirror reactor. L.F.M.

N80-31222# Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.

MHD ELECTRODE DEVELOPMENT Quarterly Report, Oct. - 30 Dec. 1979

John W. Sadler, Laurence H. Cadoff, Jeff Bein, W. Dean Coe, Jr., James A. Dilmore (Westinghouse Research and Development Center), Edsel W. Fratti, Dave Jacobs, Edgar L. Kochka, Jack A. Kuszyk, S. K. Lau et al Feb. 1980 119 p refs (Contract DE-AC01-79ET-15529)

(FE-15529-5) Avail: NTIS HC A06/MF A01

Results of bonding studies in support of an evaluation of platinum capped anodes and iron cathodes are presented. In addition, an attachment technique has been developed for bonding the indium-doped hafnia current leadout material to a compliant nickel mesh and results are reported. Laboratory electrochemical corrosion tests indicate that major reductions in polarization, electrical resistivity and ionic transference number of the slag can be achieved with moderate additions of cobalt which will produce a significant reduction in the electrochemical stress. Status of design, procurement and modification activities in support of the installation of a conventional three tesla magnet is presented.

# N80-31253# Oak Ridge National Lab., Tenn. ADVANCED DESIGNS FOR HIGHLY STABLE SUPERCONDUCTOR SYSTEMS

J. W. Lue and J. R. Miller 1979 11 p refs Presented at 8th Symp. on Eng. Probl. of Fusion Res., San Francisco, 13 Nov. 1979

(Contract W-7405-eng-26)

(CONF-791102-148) Avail: NTIS HC A02/MF A01

A basic conductor design is given to take advantage of the enhanced stability of cable-in-conduct conductors brought about by transient pressure waves in helium. The design is discussed in terms of manufacturability, performance, and applicability in large fusion magnets. A few small scale test conductors have been constructed. Preliminary test results on the performance of one of them is included. Possible variations offered by the flexibility of the basic design is also discussed.

N80-31273# Jet Propulsion Lab., California Inst. of Tech.,

ELECTRIC AND HYBRID VEHICLE SYSTEM RESEARCH AND DEVELOPMENT PROJECT, HYBRID VEHICLE POTEN-TIAL ASSESSMENT. VOLUME 4: SERIES SYSTEMS

Z. Popinski 30 Sep. 1979 76 p 10 Vol. (Contract EM-78-I-01-4209)

(CONS-4209-T1-Vol-4) Avail: NTIS HC A05/MF A01

An evaluation of the series configuration is presented. The series configuration has the advantage that the engine is mechanically uncoupled from the wheels and can be operated at its best economy point much of the time. The mechanical energy produced by the engine is converted through a generator into electrical energy which is used to drive the motor or charge the batteries. This configuration offers a good degree of flexibility. It has the disadvantage that substantial losses of energy occur since the mechanical energy from the engine passes through several components before being used to drive the wheels. The energy produced by the engine is reduced by the product of efficiencies of components connected in series. Trade-offs involved in the study of the series configurations were directed toward establishing the size of the engine, motor and generator to meet vehicle acceleration performance; determining what level to operate the engine, and determining when to use the battery. These results were then used in the electric range simulation.

N80-31869\*# United Technologies Corp., South Windsor, Conn. Power Systems Div.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY

NTIS

(CTAS). VOLUME 3: ENERGY CONVERSION SYSTEM **CHARACTERISTICS** Final Report

Jan. 1980 283 p refs (Contracts DEN3-30; EC-77-A-31-1062)

(NASA-CR-159761; DOE/NASA/0030-80/3-Vol-3;

UTC-FCR-1333-Vol-3) Ávail: NTIS HC A13/MF A01 CSCL 10B

Six current and thirty-six advanced energy conversion systems were defined and combined with appropriate balance of plant equipment. Twenty-six industrial processes were selected from among the high energy consuming industries to serve as a frame work for the study. Each conversion system was analyzed as a cogenerator with each industrial plant. Fuel consumption, costs, and environmental intrusion were evaluated and compared to corresponding traditional values. The advanced energy conversion technologies indicated reduced fuel consumption, costs, and emissions. Fuel energy savings of 10 to 25 percent were predicted compared to traditional on site furnaces and utility electricity. With the variety of industrial requirements, each advanced technology had attractive applications. Fuel cells indicated the greatest fuel energy savings and emission reductions. Gas turbines and combined cycles indicated high overall annual savings. Steam turbines and gas turbines produced high estimated returns. In some applications, diesels were most efficient. The advanced technologies used coal derived fuels, or coal with advanced fluid bed combustion or on site gasifications. Data and information for both current and advanced energy conversion technology are presented. Schematic and physical descriptions, performance data, equipment cost estimates, and predicted emissions are included. Technical developments which are needed to achieve commercialization in the 1985-2000 period are identified.

N80-31870\*# General Electric Co., Philadelphia, Pa. Power Systems Engineering.

COGENERATION TECHNOLOGY ALTERNATIVES STUDY (CTAS). VOLUME 3: INDUSTRIAL PROCESSES Final Report

W. B. Palmer, H. E. Gerlaugh, and R. R. Priestley Apr. 1980 478 p Sponsored by DOE

(Contract DEN3-31)

(NASA-CR-159767: DOE/NASA/0031-80/3-Vol-3;

GE80ET0104-Vol-3) Avail: NTIS HC A21/MF A01 10B

Cogenerating electric power and process heat in single energy conversion systems rather than separately in utility plants and in process boilers is examined in terms of cost savings. The use of various advanced energy conversion systems are examined and compared with each other and with current technology systems for their savings in fuel energy, costs, and emissions in individual plants and on a national level. About fifty industrial processes from the target energy consuming sectors were usedas a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed cycle and steam injected gas turbines, and fuel cells. Fuels considered were coal, both coal and petroleum based residual and distillate liquid fuels, and low Btu gas obtained through the on site gasification of coal. An attempt was made to use consistent assumptions and a consistent set of ground rules specified by NASA for determining performance and cost. Data and narrative descriptions of the industrial processes are given. R.K.G.

N80-31881\*# National Aeronautics and Space Administration, Washington, D. C.

#### COMPOSITE ROTOR BLADES FOR LARGE WIND ENERGY INSTALLATIONS

A. Kussmann, J.P. Molly, and D. Muser Apr. 1980 14 p refs Transl. into ENGLISH from DFVLR-Nachr. (West Germany), Jun. 1979 p 40-44 Original language document was announced as A79-41235 Transl by Scientific Translation Service, Santa Barbara, Calif.

(Contract NASw-3198)

(NASA-TM-75822) Avail: NTIS HC A02/MF A01 CSCL 10B

The design of large wind power systems in Germany is reviewed with attention given to elaboration of the total wind energy system, aerodynamic design of the rotor blade, and wind loading effects. Particular consideration is given to the development of composite glass fiber/plastic or carbon fiber/plastic rotor blades for such installations.

N80-31882\* # Westinghouse Research and Development Center, Pittsburgh, Pa.

CELL MODULE AND FUEL CONDITIONER Quarterly Report. Apr. - Jun. 1980

D. Q. Hoover, Jr. Jul. 1980 75 p

(Contracts DEN3-161: DE-AI 03-79ET-11272)

(NASA-CR-159888; DOE/NASA/0161-4;

Rept-80-9E6-MARED-R3; QR-3) Avail: NTIS

HC A04/MF A01 CSCL 10A

The computer code for the detailed analytical model of the MK-2 stacks is described. An ERC proprietary matrix is incorporated in the stacks. The mechanical behavior of the stack during thermal cycles under compression was determined. A 5 cell stack of the MK-2 design was fabricated and tested. Designs for the next three stacks were selected and component fabrication initiated. A 3 cell stack which verified the use of wet assembly and a new acid fill procedure were fabricated and tested. Components for the 2 kW test facility were received or fabricated and construction of the facility is underway. The definition of fuel and water is used in a study of the fuel conditioning subsystem. Kinetic data on several catalysts, both crushed and pellets, was obtained in the differential reactor. A preliminary definition of the equipment requirements for treating tap and recovered water was developed.

N80-31885# RAND Corp., Santa Monica, Calif. A QUANTITATIVE EVALUATION OF CLOSED-CYCLE OCEAN THERMAL ENERGY CONVERSION (OTEC) TECH-

**NOLOGY IN CENTRAL STATION APPLICATIONS** E. C. Gritton, R. Y. Pei, J. Aroesty, M. M. Balaban, C. Gazley, R. W. Hess, and W. H. Krase May 1980 137 p refs (Contract DE-AC01-79PE-70078)

(R-2595-DOE) Avail: NTIS HC A07/MF A01

An evaluation of a closed cycle Ocean Thermal Energy Conversion (OTEC) system for delivery of electric power to the United States is presented. Performance and costs of complete commercial OTEC systems are analyzed at the system level using inputs from component analyses and thermal resource data in the Gulf of Mexico. Such sites could feed the Gulf Coast from the west coast of Florida to the New Orleans area. By exploiting the temperature difference between warm surface waters and cold water from the depths to operate a thermodynamic cycle to generate electricity, OTEC acts as a heat engine that taps the surface waters of tropical and subtropical oceans as a heat source and the cold water originating in the polar regions as a heat sink. Results of the engineering analysis indicate that the system and platform appear to be within the state-of-the-art.

N80-31922# Gilbert/Commonwealth, Reading, Pa.
FEASIBILITY STUDY: FUEL CELL COGENERATION IN A WATER POLLUTION CONTROL FACILITY, VOLUME 1 Final Report

J. H. Hirschenhofer, D. B. Baillieul, L. M. Barton, R. J. Brumberg, C. E. Hannan, H. H. Fiedler, M. G. Kile, M. G. Klett, G. A. Malone, H. P. Milliron et al Feb. 1980 151 p refs Prepared in cooperation with the Bergen County Utilities Authority, Little Ferry, N.J.; Public Service Electric and Gas Co., Newark, N.J.; and United Technologies Corp., East Hartford, Conn. (Contract DE-AC03-78ET-12431)

(DOE/ET-12431/T1-Vol-1) Avail: NTIS HC A08/MF A01

A conceptual design study was conducted to investigate the technical and economic feasibility of a cogeneration fuel cell power plant operating in a large water pollution control facility. In this particular application, the fuel cell power plant would use methane rich digester gas from the water pollution control facility as a fuel feedstock to provide electrical and thermal energy. Several design configurations were evaluated. These configurations were comprised of combinations of options for locating the fuel cell power plant at the site, electrically connecting it with the water pollution control facility, using the rejected

power plant heat, supplying fuel to the power plant, and for ownership and operation. A configuration was selected which met institutional/regulatory constraints and provided a net cost savings to the industry and the electric utility.

N80-31929# General Accounting Office, Washington, D. C. FEDERAL DEMONSTRATIONS OF SOLAR HEATING AND COOLING ON COMMERCIAL BUILDINGS HAVE NOT BEEN **VERY EFFECTIVE** 

15 Apr. 1980 46 p

(EMD-80-41) Avail: NTIS HC A03/MF A01

An analysis is provided of the commercial buildings solar heating and cooling demonstration program implemented by DOE. A discussion of the objectives of the law authorizing the program and an evaluation of the success of the program in meeting those objectives are included. Practicality, data dissemination, and development of a viable solar industry are discussed. DOE

N80-31935# Institute of Gas Technology, Chicago, III. FUEL CELL RESEARCH ON SECOND-GENERATION MOLTEN-CARBONATE SYSTEMS Technical Report, 1 Jul. - 30 Sep. 1979

Dec. 1979 116 p refs (Contract DE-ACO3-78ET-11276; Proj. 61021)

(SAN-11276-2) Avail: NTIS HC A06/MF A01

The development and testing of fuel cell components is discussed. Structural analysis of the cell package showed that electrolyte tile cracking caused by thermal cycling can be greatly reduced by reducing the thermal expansion difference between the cell separator plate and the electrolyte tile and by reducing the ratio of the separator plate thickness to the electrolyte tile thickness. Mechanical property measuremens were made on a variety of electrolyte tile compositions. The tile microstructure (agglomerate size and LiAIO2 distribution) strongly affected the tile strength. Carbonate compositions were identified that matched more closely the thermal expansion of the metallic cell components. Cell testing of these compositions showed good performance. A potentially cost effective method of fabricating electrolyte tiles and electrodes using the tape-casting method was demonstrated. In addition, good powder quality was achieved using the spray-drying technique for electrolyte powder preparation. DOE

N80-31936# Aerodyne Research, Inc., Bedford, Mass. CHARACTERIZATION OF OPEN-CYCLE, COAL-FIRED MHD GENERATORS Quarterly Technical Progress Report, 1 Jul. 1978 - 30 Apr. 1979

C. E. Kolb, J. Wormhoudt, V. Yousefian, W. Cheng, F. Bien, M. Martinez-Sanchez, and J. Silver May 1979 100 p refs (Contract EX-76-C-01-2478)

(ARI-RP-43; QTPR-9; QTPR-10) HC A05/MF A01

The successful design of full scale open cycle, coal fired MHD generators for baseload electrical production requires a detailed understanding of the plasma chemical and plasma dynamic characteristics of anticipated combustor and channel fluids. Progress in efforts to model negative ion formation and slag condensation effects on core flow conductivity, to improve the ability to sample and characterize laboratory produced coal combustion plasmas, and to measure mechanisms and rates of slag oxide condensation are discussed. A set of parametric calculations showing the influence of various input parameters on a nominal full scale, supersonic generator system is also presented.

N80-31937# United Technologies Corp., South Windsor, Conn. Power Systems Div.

AC/DC POWER CONVERTER FOR BATTERIES AND FUEL **CELLS Annual Report** 

R. W. Rosati, J. L. Peterson, and J. R. Vivirito Dec. 1979 211 p refs

(EPRI Proj. 841-1)

(EPRI-EM-1286) Avail: NTIS HC A10/MF A01

The leading commutating circuit options for an advanced self-commutated-type power converter were tested and analyzed by computer simulation. An analytical and experimental evaluation of advanced commutation circuits, and evaluation of alternative

advanced bridge design, selection of the most desirable conceptual design, and the development of a mathematical models converter response are described. Experimental data and preliminary converter specifications are contained in the ap-DOE

N80-31938# United Technologies Corp., South Windsor, Conn. Power Systems Div.

DEVELOPMENT OF MOLTEN CARBONATE FUEL CELL POWER PLANT TECHNOLOGY Quarterly Technical Progress Report, 1 Oct. - 31 Dec. 1979

H. C. Healy, R. A. Sanderson, R. J. Wertheim, P. F. Farris, A. P. Mientek, R. C. Nickols, M. Katz, R. P. Iczkowski, R. R. Fredley, R. C. Stewart et al Mar. 1980 80 p (Contract DE-AC01-79ET-15440)

(DOE/ET-15440/1; QTPR-1) Avail: NTIS HC A05/MF A01 A study baseline fuel cell system and module configuration were established. Studies to determine user requirements and to characterize the fuel cell power block and coal gasifier subsystems were initiated. Cell stack design was initiated with completion of preliminary design requirements for the cell cathodes. Laboratory tests were also initiated to identify alternative materials for separator plates, reactant manifold seals, and electrolyte tile fillers. A mechanical tape casting technique for producing 18 x 24 inch sheets of electrolyte matrix tape was successfully demonstrated. Theoretical and experimental studies were initiated to define the effects of known sulfur contaminants on cell performance. A literature survey was initiated to identify other possible contaminants. Planning and design efforts for construction of a mobile cell test unit were initiated. The mobile unit will be used to verify the molten carbonate cell's ability to operate on gasified coal by tests at a gasifier site.

N80-31945# Massachusetts Univ., Amherst. CONTINUED EVALUATION OF COMPACT HEAT EXCHANG-**ERS FOR OTEC EVALUATION** Final Report

J. G. McGowan DOE Oct. 1979 141 p refs (Contract EG-77-S-02-4238)

(COO-4238-14) Avail: NTIS HC A07/MF A01

Investigations were carried out to establish the applicability of compact plate type heat exchangers to OTEC power systems and to (1) provide experimental verification of predicted performance (heat transfer and fluid flow) under OTEC operating conditions (using NH2); (2) provide initial performance data for several desirable plate type OTEC heat exchanger panels. (3) provide test apparatus for continued experimental testing of OTEC compact heat exchanger panels; and (4) provide design information on applicable manufacturing processes maintenance requirements and arrangement concepts for plate type heat exchangers.

N80-31951\*# Argonne National Lab., III. Integrated Assessments and Policy Evaluations Group.

METHODOLOGY FOR THE COMPARATIVE ASSESSMENT OF THE SATELLITE POWER SYSTEM (SPS) AND ALTERNA-TIVE TECHNOLOGIES

T. Wolsko, W. Buehring, R. Cirillo, J. Gasper, L. Habegger, K. Hub, D. Newsom, M. Samsa, E. Stenehjem, and R. Whitfield Jan. 1980 79 p refs Sponsored by NASA (Contract W-31-109-eng-38)

(NASA-CR-163049: DOE/ER-0051) Avail: **NTIS** 

HC A05/MF A01

The energy systems concerned are the satellite power system, several coal technologies, geothermal energy, fission, fusion, terrestrial solar systems, and ocean thermal energy conversion. Guidelines are suggested for the characterization of these systems, side-by-side analysis, alternative futures analysis, and integration and aggregation of data. A description of the methods for assessing the technical, economic, environmental, societal, and institutional issues surrounding the development of the selected energy technologies is presented.

N80-31958# New Mexico Univ., Albuquerque. Civil Engineering Research Facility.

AUTOMATIC-CONTROL SYSTEM FOR THE 17-METRE VERTICAL AXIS WIND TURBINE (VAWT)

Gerald M. McNerney Mar. 1980 49 p refs (Contract EY-76-C-04-0789) (SAND-78-0984) Avail: NTIS HC A03/MF A01

An automatic control system was designed and implemented to study automatic control of a vertical axis wind turbine (VAWT) and to better judge the fatigue life and reliability of the VAWT under what will be normal operating conditions for power production. This system, including the necessary hardware, is discussed in detail along with a simplified cost analysis.

N80-31960# Little (Arthur D.), Inc., Cambridge, Mass.
LARGE WIND TURBINE GENERATOR PERFORMANCE
ASSESSMENT Technology Status Report
W. A. Vachon Jan. 1980 90 p. refs. Sponsored by Electric

W. A. Vachon Jan. 1980 90 p refs Sponsored by Electric Power Research Inst. [EPRI Proj. 1348-1]

(EPRI-AP-1317; TSR-1) Avail: NTIS HC A05/MF A01

Large wind turbine generator development and field test activities are presented. An approach for gathering, distilling, and assessing WT test data is presented, with emphasis on the usefulness of the data to the industry.

N80-31965# National Technical Information Service, Springfield, Va.

WIND POWER. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1979 - May 1980

Audrey S. Hundemann Jun. 1980 145 p Supersedes NTIS/PS-79/0534; NTIS/PS-78/0416 (PB80-811458; NTIS/PS-79/0534; NTIS/PS-78/0416) Avail:

NTIS HC \$30.00/MF \$30.00 CSCL.10B

The feasibility, use and engineering aspects of wind power and windmills are discussed in these citations of Federally funded research reports. Abstracts primarily cover the use of wind power for electric power generation and wind turbine design and performance. General studies dealing with comparative analyses of wind power and alternative energy sources are included, as are energy storage devices which can be used in these systems. This updated bibliography contains 135 abstracts, 112 of which are new entries to the previous edition.

N80-32226# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

TESTS OF A LIGHTWEIGHT 200 kW MHD CHANNEL AND DIFFUSER Final Report, Mar. 1977 - Dec. 1978

James F. Holt and Jerome Pearson Mar. 1980 175 p refs

(AF Proj. 3145) (AD-A087022: AFWAL-TR-80-2021) Avail: NTIS

(AD-A087022; AFWAL-TR-80-2021) Avail: NTIS HC A08/MF A01 CSCL 10/2 A 200 kW lightweight MHD generator channel and diffuser

A 200 kW lightweight MHD generator channel and diffuser were tested over a regime of 235 individual firings of the open cycle combustor systems. The diagonal conducting wall channel delivered full rated power with no interelectrode breakdown. Vibration measurements indicated no fatigue of the channel structure.

N80-32231# Arnold Engineering Development Center, Arnold Air Force Station, Tenn.

MHD HIGH PERFORMANCE DEMONSTRATION EXPERIMENT Quarterly Progress Report, 1 Oct. - 31 Dec. 1979

Jan. 1980 44 p

(Contract ET-78-I-01-2895)

(FE-2895-7) Avail: NTIS HC A03/MF A01

The attainment of MHD performance on a sufficiently large scale to verify that the projected efficiency of the commercial MHD concept is considered. Shakedown testing of the magnet and flow train was completed and operation of the HPDE system in the Faraday power producing mode has continued. A peak power of about 18 MW was produced with a magnetic field of 2.8 T. Significant results which were obtained involved a definition of the transverse voltage characteristics, including the voltage drop near the electrode walls, and a definition of the fluid flow through the channel and diffuser. Several operational problems were encountered including erosion of heat sink components of the burner and channel entrance and Hall potential shorting at the aft end of the channel and diffuser. Required hardware

procurement and modification were initiated by the end of the quarter to solve these problems.

N80-32233# General Atomic Co., San Diego, Calif.
CONCEPTUAL DESIGN OF RST: AN rf-DRIVEN, STEADYSTATE TOKAMAK, Final Report

R. Prater, D. Bhadra, L. Bikadi, R. Bourque, W. Chen, C. Chu, J. Dalessandro, R. Harvey, M. Henderson, T. Ohino et al. Mar. 1980 251 p. refs (EPRI Proj. 323-3)

(EPRI-AP-1351) Avail: NTIS HC A12/MF A01

The preliminary conceptual design of a radio frequency driven, steady state Tokamak (RST), is described. The function of RST was to develop the physics and engineering bases for the development of the Tokamak as a true steady state reactor. The physics of radio frequency current drive, using a variety of electromagnetic waves, is discussed. The device made use of a novel superconducting toroidal magnetic field coil concept, in which the axial current was carried in only three return legs, and superconducting pullback coils were used to reduce the magnetic field ripple. This technique greatly increases access to the plasma. Impurity control by means of edge cooling, bundle divertor, and radio frequency wave momentum sources is discussed, as well as fueling.

N80-32234# Aerodyne Research, Inc., Bedford, Mass.
CHARACTERIZATION OF OPEN-CYCLE, COAL-FIRED MHD
GENERATORS Quarterly Technical Progress Report,
1 May - 31 Jul. 1979

C. E. Kolb, J. Wormhoudt, V. Yousefian, W. Cheng, F. Bien, D. Dvore, and M. Martinez-Sanchez Aug. 1979 88 p refs (Contract EX-76-C-01-2478)

(ARI-RP-46; QTPR-11) Avail: NTIS HC A05/MF A01

A diffusion controlled heterogeneous condensation model and channel heat loss model for incorporation into the PACKAGE code used to calculate core flow plasma properties and generator efficiency were developed. PACKAGE calculations comparing realistic baseload subsonic and supersonic generator models are also presented. The refinement of a laboratory scale coal combustion plasma source and its associated molecular beam mass spectrometer diagnostic and diode laser absorption plasma temperature measurement systems was documented. A numerical model describing arc behavior in magnetohydrodynamic electrode boundary layers is presented.

N80-32462# American Wind Energy Association, Washington, D.C.

CAPITAL FORMATION FOR SMALL WIND ENERGY CONVERSION SYSTEM MANUFACTURERS: A GUIDE TO METHODS AND SOURCES Final Report

Peter. H. Smeallie and Benjamin Wolff May 1980 55 p refs Prepared in cooperation with Vonier (Thomas) Associates, Inc., Washington, D.C.

(Contract EG-77-C-01-4042)

(SERI/TR-98298-1) Avail: NTIS HC A04/MF A01

Sources of capital are described and the development of a business plan explained. Case histories of four wind companies' experiences in raising capital are included.

DOE

N80-32719\*# Chrysler Corp., Detroit, Mich.
UPGRADED AUTOMOTIVE GAS TURBINE ENGINE DESIGN

AND DEVELOPMENT PROGRAM, VOLUME 2 Final Report C. E. Wagner, ed. and R. C. Pampreen, ed. Jun. 1979 348 p. refs Sponsored by NASA

(Contracts EY-76-C-02-2749; EC-77-A-31-1040) (NASA-CR-159671; DOE/NASA/2749-79/2-Vol-2;

COO-2749-43-Vol-2) Avail: NTIS HC A15/MF A01 CSCL

Results are presented for the design and development of an upgraded engine. The design incorporated technology advancements which resulted from development testing on the Baseline Engine. The final engine performance with all retro-fitted components from the development program showed a value of 91 HP at design speed in contrast to the design value of 104 HP. The design speed SFC was 0.53 versus the goal value of 0.44. The miss in power was primarily due to missing the

efficiency targets of small size turbomachinery. Most of the SFC deficit was attributed to missed goals in the heat recovery system relative to regenerator effectiveness and expected values of heat loss. Vehicular fuel consumption, as measured on a chassis dynamometer, for a vehicle inertia weight of 3500 lbs., was 15 MPG for combined urban and highway driving cycles. The baseline engine achieved 8 MPG with a 4500 lb. vehicle. Even though the goal of 18.3 MPG was not achieved with the upgraded engine, there was an improvement in fuel economy of 46% over the baseline engine, for comparable vehicle inertia weight.

Author

DOF

N80-32722# United Technologies Corp., East Hartford, Conn. UTRC 8 KW WIND TURBINE TESTS

M. C. Cheney 1980 9 p refs Presented at the Wind Energy Conf., Boulder, Colo., 9 Apr. 1980 (Contract DE-AC04-76DP-03533)

(RFP-3085; CONF-800406-5) Avail: NTIS HC A02/MF A01
The prototype testing demonstrated the basic operation of the unique control concept of the Composite Bearingless Wind Turbine which utilizes a hub mounted pendulum employed to twist the graphite composite inboard region of the blade producing blade pitch variations. The tests also demonstrated the predicted performance of kW at 20 mph, and the high speed stall control

N80-32723# Advanced Mechanical Technology, Inc., Newton,

DESIGN AND DEVELOPMENT OF STIRLING ENGINES FOR STATIONARY POWER GENERATION APPLICATIONS IN THE 500 TO 3000 HORSEPOWER RANGE Quarterly Report

7 Jan. 1980 98 p (Contract DE-AC02-79ET-15207)

feature.

(DOE/ET-15207/T1: QR-1) Avail: NTIS HC A05/MF A01 Factors considered in the generation of state of the art conceptual designs for a Stirling engine capable of being fueled by a variety of heat sources are discussed with emphasis on coal firing. Designs having the the greatest potential for fabrication, testing and demonstration in 1985 are considered as well as advanced technologies which require significant R and D before commercialization. Concepts examined include a heat transport system for integrating the engine heater head with such energy sources as conventional oil gas combustors, fluidized bed and other coal combustors, and combustors using coal derived liquid fuels and low/medium Btu gases.

N80-32729# General Electric Co., Schenectady, N. Y. Gas Turbine Div.

HIGH-TEMPERATURE TURBINE TECHNOLOGY PROGRAM.
OVERALL PLANT DESIGN DESCRIPTION (OPDD) LOW-Btu
COAL GAS ELECTRIC POWER PLANT

M. W. Horner Mar. 1980 241 p (Contract EX-76-C-01-1806)

(FE-1806-83) Avail: NTIS HC A11/MF A01

A highly reliable, commercially viable system based on coal derived fuel is described. The system consists mainly of high temperature, water cooled gas turbines that burn coal derived gas fuel, and a steam bottoming cycle with one reheat steam turbine. The combined cycle system provides improved flexibility of operation as well as reliability and efficiency.

N80-32858\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

LARGE WIND TURBINES: A UTILITY OPTION FOR THE GENERATION OF ELECTRICITY

W. H. Robbins, R. L. Thomas, and D. H. Baldwin 1980 18 p refs Presented at the Am. Power Conf., Chicago, 21-23 Apr. 1980: sponsored by Illinois Inst. of Tech.; presented at the Ann. Solar Energy Program Rev., Rockport, Maine, 26-28 Aug. 1980: sponsored by Electric Power Research Inst.

(Contract DE-AIO1-79ET-23139)

(NASA-TM-81502; DOE/NASA/23139-1; E-440) Avail: NTIS HC A02/MF A01 CSCL 10B

The wind resource is such that wind energy generation has the potential to save 6-7 quads of energy nationally. Thus, the

Federal Government is sponsoring and encouraging the development of cost effective and reliable wind turbines. One element of the Federal Wind Energy Programs, Large Horizontal Axis Wind Turbine Development, is managed by the NASA Lewis Research Center for the Department of Energy. There are several ongoing wind system development projects oriented primarily toward utility application within this program element. In addition, a comprehensive technology program supporting the wind turbine development projects is being conducted. An overview is presented of the NASA activities with emphasis on application of large wind turbines for generation of electricity by utility systems.

N80-32864# Avco-Everett Research Lab., Mass.

OPEN-CYCLE MHD POWER CONDITIONING AND CONTROL REQUIREMENTS DEFINITION Final Report

S. Petty and K. Williams Mar. 1980 70 p refs

(EPRI-AP-1345) Avail: NTIS HC A04/MF A01

A generic inverter configuration is defined, and the relevant characteristics of line and forced commutated inverters are compared and evaluated for their suitability for magnetohydrodynamic (MHD) power application. The interface requirements of an MHD channel inverter utility interactive system are defined, and a forced commutated inverter meeting these requirements is described. The results of a set of tests using this inverter are described along with recommendations for future work in this field.

N80-32885# SRI International Corp., Menlo Park, Calif. DIRECT ELECTROCHEMICAL GENERATION OF ELECTRICITY FROM COAL Progress Report, 18 May 1977 - 15 Feb. 1979

Robert D. Weaver, Steven C. Leach, Arthur E. Bayce, and Leonard Nanis 1979 151 p refs (Contract EY-76-C-03-0115)

(SAN-0115/105-1) Avail: NTIS HC A08/MF A01

The feasibility of the coal air fuel cell was investigated. Results of fabrication of anodes from coal, the factors influencing cell design and voltage current behavior of the carbon anode, and results of materials selection for the air cathode are among the topics discussed. The overall thermal efficiency of a nonoptimized plant is calculated and presented. The results indicate a nonpolluting process equivalent to or exceeding present day thermal efficiencies. Conservative analysis for a plant with carbon pellet anode feed and bottoming thermal recovery indicates an overall efficiency of 53.3% and a cost of \$758 per kilowatt (638 MW plant, 1978 dollars). This cost is below competing molten carbonate systems using gaseous anode feed.

N80-32866# Braun (C. F.) and Co., Alhambra, Calif.
ASSESSMENT OF SULFUR REMOVAL PROCESSES FOR
ADVANCED FUEL CELL SYSTEMS Final Report

G. A. Lorton Jan. 1980 156 p refs Sponsored by Electric Power Research Inst.

(EPRI-EM-1333) Avail: NTIS HC A08/MF A01

The performance characteristics of potential sulfur removal processes were evaluated and four of these processes, the Selexol process, the Benfield process, the Sulfinol process, and the Rectisol process, were selected for detailed technical and economic comparison. The process designs were based on a consistent set of technical criteria for a grass roots facility with a capacity of 10,000 tons per day of Illinois No. 6 coal. Two raw gas compositions, based on oxygen blown and air blown Texaco gasification, were used. The bulk of the sulfur was removed in the sulfur removal unit, leaving a small amount of sulfur compounds in the gas. The remaining sulfur compounds were removed by reaction with zinc oxide in the sulfur polishing unit. The impact of COS hydrolysis pretreatment on sulfur removal was evaluated. Comprehensive capital and O and M cost estimates for each of the process schemes were developed.

N80-32877# United Technologies Corp., South Windsor, Conn. Power Systems Div.

ADVANCED TECHNOLOGY FUEL CELL PROGRAM Annual Report

J. A. S. Bett, C. L. Bushnell, R. F. Buswell, G. A. Gruver, J. M. King, and H. R. Kuna 1980 116 p refs (EPRI-EM-1328) Avail: NTIS HC A06/MF A01

Efforts were undertaken to establish a basis for the engineering development of an improved fuel cell power plant. These focused on molten carbonate fuel cells, advanced reformers, and use of coal products. Molten carbonate cell configurations were developed that are capable of enduring thermal cycles and were demonstrated in square foot stacks of 8 and 20 cells. Subscale cells were tested at pressures of up to 5 atmospheres with little, if any, carbon or methane formation in the fuel cell. In addition, an adiabatic, a hybrid, and a cyclic reformer were evaluated.

N80-32878# Diamond Shamrock Chemical Co., Cleveland, Ohio. Electrolytic Systems Div.

OXYGEN ELECTRODES FOR ENERGY CONVERSION AND STORAGE Annual Report, 1 Oct. 1977 - 30 Sep. 1978 1980 362 p refs

(Contract EC-77-C-02-4146)

(DOE/ET-25502/1) Avail: NTIS HC A16/MF A01

Very active oxygen electrocatalysts and their incorporations into high performance electrode structures were developed. These long life oxygen electrodes were designed for a spectrum of applications including industrial electrolysis, fuel cells, and metal air batteries. The operating life and initial cost of oxygen cathodes was developed.

T.M.

N80-32881# Westinghouse Electric Corp., Pittsburgh, Pa. OPEN-CYCLE MHD SYSTEMS ANALYSIS Final Report T. E. Lippert and K. D. Weeks Feb. 1980 511 p refs (EPRI Proj. 640-1)

(EPRI-AP-1316) Avail: NTIS HC A22/MF A01

Five variant configurations of a coal burning open cycle magnetohydrodynamic electric power generating facility were studied for evaluation as candidate first generation power plants. A material and energy balance and cycle analysis was performed for each case to provide information for the conceptual designs and costing of all major MHD related components and subsystems as well as specification of other state of the art components. A economic comparison was made of each design by developing the cost of electricity based on component costs, estimates of operation and maintenance requirements, and the performance of each plant from the system analyses. An overall description of each plant is provided along with discussions of critical component and process development. An oxygen enriched OCMHD plant design was identified as an attractive candidate for first generation utility service. This plant design appears to offer competitive costs of electricity and minimizes development

N80-32942# Public Service Electric and Gas Co., Newark, N. J.
DISTRICT HEATING AND COOLING SYSTEMS FOR
COMMUNITIES THROUGH POWER PLANT RETROFIT
DISTRIBUTION NETWORK, VOLUME 4 Final Report, 1 Sep.
1978 - 31 May 1979

Oct. 1979 154 p

(Contract EM-78-C-02-4977)

(COO-4977/1-Vol-4) Avail: NTIS HC A08/MF A01

Institutional factors, legal and regulatory aspects, a preliminary economic analysis, and a proposal for future studies on retrofitting existing thermal power plants are presented. The data is utilized so that the thermal plants can supply heat for district heating and cooling systems for communities.

N80-32943# Avco-Everett Research Lab., Mass.
ENGINEERING TEST FACILITY CONCEPTUAL DESIGN
Final Technical Report

Feb. 1980 159 p

(Contract EF-77-C-01-2614)

(DOE/FE-2614/3) Avail: NTIS HC A08/MF A01

The power system configuration originally specified for the ETF considered the use of a high temperature air preheater, separately fired initially with oil and subsequently with a L8tu gas produced in a coal gasifier integrated with the power plant. This eliminates the need for a high temperature air preheater and its associated gasifier. The results from initial parametric design analysis in the separate study of early commercial MHD power plants reinforced the potential attractiveness of the use

of oxygen enrichment of the combustion air. Preliminary analysis of the use of oxygen enrichment for ETF is also included. DOE

N80-32950# Massachusetts Univ., Amherst. Energy Alternatives Program.

INVESTIGATION OF THE FEASIBILITY OF USING WIND POWER FOR SPACE HEATING IN COLDER CLIMATES Annual Report, period ending 30 Jun. 1978

D. E. Cromack Oct. 1979 116 p refs (Contract DE-AC04-76DP-03533)

(DOE/DP-03533/T3) Avail: NTIS HC A06/MF A01

Background and progress to date for the Wind Furnace Project at the University of Massachusetts is reported. The Wind Furnace installed at Solar Habitat-1 is described. More detail is presented under the summary discussions for each task with referenced technical reports and published papers giving a full description of the specific tasks.

N80-32951# Georgia Inst. of Tech., Atlantà, School of Geophysical Sciences.

## ANALYTICAL STUDIES OF WIND TURBINE TURNING CHARACTERISTICS

A. S. Mikhail and C. G. Justus Jun. 1979 26 p refs (Contracts DE-AS06-76ET-20355)

(RLO/2439-79/3) Avail: NTIS HC A03/MF A01

Data from 14 sites were arranged in time-series format for wind speed and direction. The sites were chosen based on the availability of hourly observations and suitability of the sites for wind energy applications. The hourly turns of the wind were summed vectorially. Monthly and annual cummulative turns at each site were computed. To simulate the performance of actual wind turbines, threshold wind speed values of 0, 1, 2, 3, 4, 5, and 6 m/s were chosen. A threshold wind speed is defined as wind speed below which the turbine is not expected to turn with the wind.

N80-32956# Midwest Research Inst., Golden, Colo. Technical Information Dissemination Program.

PROCEEDINGS OF THE OCEAN ENERGY INFORMATION DISSEMINATION WORKSHOP

Don Petty Solar Energy Research Inst. Apr. 1980 22 p Workshop held in Golden, Colo., 6-7 Dec. 1979 (Contracts EG-77-C-01-4042; DE-AC02-77CH-00178) (SERI/TP-732-600) Avail: NTIS HC A02/MF A01

The workshop was held to discuss the status of marketing ocean energy information and to develop an understanding of information needs and how to satisfy them. Presentations were made by the Solar Energy Research Institute (SERI) staff and media consultants about the effective use of audio visual and print products, the mass media, and audience needs. Industry and government representatives reported on current efforts in each of their communication programs and outlined future plans. Four target audiences (DOE contractors, researchers, influencers, and general public) were discussed with respect to developing priorities for projects to enhance the commercialization of ocean energy technology.

N80-32957# United Technologies Research Center, East Hartford, Conn.

DEVELOPMENT OF AN 8 kW WIND TURBINE GENERATOR FOR RESIDENTIAL TYPE APPLICATION. PHASE 1: DESIGN AND ANALYSIS. VOLUME 1: EXECUTIVE SUMMARY

M. C. Cheney et al 25 Jun. 1979 8 p (Contract DE-AC04-76DP-03533)

(DOE/DP-03533/T1-Vol-1) Avail: NTIS 'HC A02/MF A01

Special features of the composite bearingless rotor, developed initially for helicopter application, were used in the design of a prototype wind turbine whose blade is comprised of an outer or aerodynamic portion fabricated from fiberglass using a pultrusion process, and an inner portion, called the flexbeam which is made up of unidirectional graphite epoxy. A rotor diameter of 9.4m was selected, producing more than the required 8 kW at 9m/s wind speeds, more typical of residential areas. Performance was calculated for two rotor speeds, representing two different gearbox step up ratios. Design studies and supporting analytical efforts

#### **05 ENERGY CONVERSION**

show that the 8 kW prototype satisfies program objectives relative to performance and operational characteristics. Stability and loads calculations, using stabilized helicopter aeroelastic codes, demonstrate the system is well damped under all loading conditions and operates well below allowable stress levels. System costs are running about 20% higher than the contract goals; however, reductions in the main frame and tower costs appear feasible, and would be explored in a second generation 8 kW design.

A.R.H.

N80-32960# Oak Ridge National Lab., Tenn. Energy Div. DEVELOPMENT OF AN ENERGY CONSUMPTION AND COST DATA BASE FOR FUEL CELL TOTAL ENERGY SYSTEMS AND CONVENTIONAL BUILDING ENERGY SYSTEMS

G. D. Pine, J. E. Christian, W. R. Mixon, and W. L. Jackson Jul. 1980 75 p refs

(Contract W-7405-eng-26)

(ORNL/CON-38) Avail: NTIS HC A04/MF A01

The procedures and data sources used to develop an energy consumption and system cost data base for use in predicting the market penetration of phosphoric acid fuel cell total energy systems in the nonindustrial building market are described. A computer program was used to simulate the hourly energy requirements of six types of buildings; office buildings; retail stores; hotels and motels; schools; hospitals; and multifamily residences. The simulations were done by using hourly weather tapes for one city in each of the ten Department of Energy administrative regions. Two types of building construction were considered, one for existing buildings and one for new buildings. A fuel cell system combined with electrically driven heat pumps and one combined with a gas boiler and an electrically driven chiller were compared with similar conventional systems. The methods of system simulation, component sizing, and system cost estimation are described for each system. DOE

N80-33073# Battelle Pacific Northwest Labs., Richland, Wash. WIND CHARACTERISTICS PROGRAM ELEMENT Annual Report, Jul. 1978 - Sep. 1979

L. L. Wendell, W. R. Barchet, J. R. Connell, A. H. Miller, W. T. Pennell, and D. S. Renne May 1980 209 p refs (Contract DE-AC06-76RL-01830)

(PNL-3211) Avail: NTIS HC A10/MF A01

As a service element within the Federal Wind Energy Program, the wind characteristics program element (WCPE) is established to provide the appropriate wind characteristics information to those involved in: the design and evaluation of wind energy conversion systems (WECS); energy program planning; selecting sites for WECS installation; and the operation of WECS. To effectively produce the information needed in these four categories, the WCPE, for which the Pacific Northwest Laboratory (PNL) has the responsibility for management and technical assistance, was divided into four technical program areas. During this reporting period PNL was also assigned the management responsibility for the data collection at the US Department of Energy's (DCEs) candidate sites, as well as the task of providing technical assistance to DOE evaluation and site selection panels for new candidate sites.

N80-33221\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

OPTIMAL THERMIONIC ENERGY CONVERSION WITH ESTABLISHED ELECTRODES FOR HIGH-TEMPERATURE TOPPING AND PROCESS HEATING Final Report

James F. Morris Jul. 1980 33 p refs

(Contract EC-77-A-31-1062)

(NASA-TM-81555; DOE/NASA/1062-6; E-514) Avail: NTIS

HC A03/MF A01 CSCL 201

Applied research-and-technology (ART) work reveals that optimal thermionic energy conversion (TEC) with approximately 1000 K to approximately 1100 K collectors is possible using well established tungsten electrodes. Such TEC with 1800 K emitters could approach 26.6% efficiency at 27.4 W/sq cm with approximately 1000 K collectors and 21.7% at 22.6 W/sq cm with approximately 1100 K collectors. These performances require

1.5 and 1.7 eV collector work functions (not the 1 eV ultimate) with nearly negligible interelectrode losses. Such collectors correspond to tungsten electrode systems in approximately 0.9 to approximately 6 torr cesium pressures with 1600 K to 1900 K emitters. Because higher heat-rejection temperatures for TEC allow greater collector work functions, interelectrode loss reduction becomes an increasingly important target for applications aimed at elevated temperatures. Studies of intragap modifications and new electrodes that will allow better electron emission and collection with lower cesium pressures are among the TEC-ART approaches to reduced interelectrode losses. These solutions will-provide very effective TEC to serve directly in coal-combustion products for high-temperature topping and process heating. In turn this will help to use coal and to use it well.

A.R.H.

N80-33228# Nebraska Univ. - Lincoln. Dept. of Mechanical Engineering.

PSEUDO-SHOCK AS A QUALITATIVE MODEL IN THE INVESTIGATION OF THE INFLUENCE OF WALL ROUGH-NESS ON THE PERFORMANCE OF SUPERSONIC MHD GENERATORS Final Report

GENERATORS Final Report
Pau-Chang Lu Jul 1980 94 p refs
(Grant AF-AFOSR-0083-79: AF Proj. 2308)

(AD-A088333; UNLMEPCL-80-1; AFOSR-80-0599TR) Avail:

NTIS HC A05/MF A01 CSCL 20/9

A preliminary study, based on an extension of Crocco's pseudo-shock model, has been carried out to explain and predict qualitatively the rather gradual pressure rise in a supersonic MHD generator, to account for the influence of wall roughness on the core flow. A system of non-linear ordinary differential equations is formulated for the wall layer and core, with proper electromagnetic conditions enforced at the interface. Extensive numerical experiments are also presented, which demonstrate indeed the qualitative link between the theory of MHD pseudo-shock and the observed pressure ramp caused by rough walls.

N80-33233# Los Alamos Scientific Lab., N. Mex.
TOKAMAK POLOIDAL FIELD SYSTEMS Progress Report,
1 Jan. - 31 Dec. 1979

John D. Rogers May 1980 15 p refs (Contract W-7405-eng-36)

(LA-8375-PR) Avail: NTIS HC A02/MF A01

The development of superconducting Tokamak poloidal field systems is addressed. Progress is discussed on the design of a 20 MJ, 50 kA, 7.5 T superconducting pulsed energy storage coil operated in a 1 to 2 s bipolar mode from +7.5 T to -7.5 T in 1982. Conductor development for the coil is presented. A facility that uses a traction motor energy transfer system to test coils in the 20 to 100 MJ energy range is discussed. Current interrupter development and testing for protection and energy transfer circuits are also presented.

N80-33237# California Univ., Livermore. Lawrence Livermore

TANDEM MIRROR FUSION-FISSION HYBRID STUDIES
J. D. Lee 24 Apr. 1980 27 p refs Presented at the 2d Intern. Conf. on Emerging Nucl. Energy Systems, Lausanne, Switzerland, 4-8 Apr. 1980 Submitted for publication (Contract W-7405-eng-48)
(UCRL-84018: CONF-800446-2-Rev-1) Avail: NTIS

(UCRL-84018: CONF-800446-2-Rev-1) Avail: HC A03/MF A01

The concept of combining nuclear fusion and nuclear fission techniques is discussed. Initial tandem mirror hybrid studies predict the ability to produce large amounts of fissile fuel (2 to 7 tons U233 per year from a 4000 MW plant) at a cost that adds less than 25% to the cost of power from a light water reactor. L.F.M.

N80-33247# Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering.

SYSTEMS ASSESSMENT OF HEAVY ION BEAM FUSION DRIVERS Final Report, 1 Jan. 1978 - 31 Dec. 1979

T. Kammash, C. R. Drum; and R. D. Theisen May 1980 44 p refs

(Contract DE-AC08-79DP-40039)

(DOE/DP-40039) Avail: NTIS HC A03/MF A01

A systems analysis for a fusion reactor utilizing a heavy ion-beam pellet fusion is carried out to evaluate the performance of several potential drivers. These include: hearthfire reference concepts 2 and 3: the RF linear accelerator; and the induction linac system. Accelerator systems utilizing rapid cycling synchrotrons are shown to be the least attractive drivers unless the efficiency of this component is sufficiently improved. Using a power cost formula that accounts for the accelerator operating cost it appears on the basis of available data that only one driver might fall within the economically acceptable range of producing electric power at 4 cents a kilowatt hour if certain optimistic conditions are met.

N80-33357\*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, Ohio.

WIND: COMPUTER PROGRAM FOR CALCULATION OF THREE DIMENSIONAL POTENTIAL COMPRESSIBLE FLOW ABOUT WIND TURBINE ROTOR BLADES

Djordje S. Dulikravich Oct. 1980 20 p refs (NASA-TP-1729; E-474) Avail: NTIS HC A02/MF A01 CSCL

A computer program is presented which numerically solves an exact, full potential equation (FPE) for three dimensional, steady, inviscid flow through an isolated wind turbine rotor. The program automatically generates a three dimensional, boundary conforming grid and iteratively solves the FPE while fully accounting for both the rotating cascade and Coriolis effects. The numerical techniques incorporated involve rotated, type dependent finite differencing, a finite volume method, artificial viscosity in conservative form, and a successive line overrelaxation combined with the sequential grid refinement procedure to accelerate the iterative convergence rate. Consequently, the WIND program is capable of accurately analyzing incompressible and compressible flows, including those that are locally transonic and terminated by weak shocks. The program can also be used to analyze the flow around isolated aircraft propellers and helicopter rotors in hover as long as the total relative Mach number of the oncoming flow is subsonic.

# N80-33856 Texas Univ. at Austin. EVALUATION OF HYDROPOWER POTENTIAL IN A RIVER BASIN Ph.D. Thesis

Hettigamage Cyril Kariyawasam 1980 152 p Avail: Univ. Microfilms Order No. 8021455

A methodology to evaluate the available hydropower potential in a river basin is described. The model was used to evaluate available hydropower potential in five different levels of gross and net potentials: gross precipitation potential, gross surface runoff potential, gross river potential, net potential with reservoirs meeting individual power demands, and net potential with reservoirs operating as a single system. This model requires only minimum data, available with most of the river basins of the world. The model was demonstrated by application to the San Antonio river basin in Texas. Relationships between different levels of gross and net potential are analyzed. Additional applications of this method of analysis to other natural energy sources are suggested. Modifications and improvements to the model are proposed.

N80-33859\*# General Electric Co., Schenectady, N. Y.
COGENERATION TECHNOLOGY ALTERNATIVES STUDY
(CTAS). VOLUME 4: ENERGY CONVERSION SYSTEMS
D. H. Brown, H. E. Gerlaugh, and R. R. Priestley Apr. 1980
178 p refs
(Contract DEN3-31)

(NACA CD AFORCE CERCETOLOGY

(NASA-CR-159768; GE80ET0103-Vol-4; DOE/NASA/0031-80/4-Vol-4)

HC A09/MF A01 CSCL 10B

Avail: NTIS

Industrial processes from the largest energy consuming sectors were used as a basis for matching a similar number of energy conversion systems that are considered as candidate which can be made available by the 1985 to 2000 time period. The sectors considered included food, textiles, lumber, paper, chemicals, petroleum, glass, and primary metals. The energy conversion systems included steam and gas turbines, diesels, thermionics, stirling, closed-cycle and steam injected gas turbines, and fuel

cells. Fuels considered were coal, both coal and petroleum-based residual and distillate liquid fuels, and low Btu gas obtained through the on-site gasification of coal. An attempt was made to use consistent assumptions and a consistent set of ground rules specified by NASA for determining performance and cost. The advanced and commercially available cogeneration energy conversion systems studied in CTAS are fined together with their performance, capital costs, and the research and developments required to bring them to this level of performance.

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N80-33862\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

MOD-2 WIND TURBINE FARM STABILITY STUDY Final Report

E. N. Hinrichsen Jun. 1980 170 p refs (Contracts DEN3-134; DE-AI01-79ET-20305)

(NASA-CR-165156; R35-40; DOE/NASA/0134-1) Avail: NTIS HC A08/MF A01 CSCL 10A

The dynamics of single and multiple 2.5 ME, Boeing MOD-2 wind turbine generators (WTGs) connected to utility power systems were investigated. The analysis was based on digital simulation. Both time response and frequency response methods were used. The dynamics of this type of WTG are characterized by two torsional modes, a low frequency 'shaft' mode below 1 Hz and an 'electrical' mode at 3-5 Hz. High turbine inertia and low torsional stiffness between turbine and generator are inherent features. Turbine control is based on electrical power, not turbine speed as in conventional utility turbine generators. Multi-machine dynamics differ very little from single machine dynamics. T.M.

N80-33868# National Mechanical Engineering Research Inst., Pretoria (South Africa). Aeromechanics Div.

THE AERODYNAMICS OF CONTRA-ROTATING AXIAL FLOW WIND POWER TURBINES

W. J. vanderElst Nov. 1979 28 p refs (CSIR-ME-1638; ISBN-0-7988-1467-5) HC A03/MF A01

Avail: NTIS

The special case of a contra-rotating, axial flow turbine is analyzed and it is shown in what operating regime such wind machines with contra-rotating rotors are superior to the conventional single rotor turbine. Nondimensional parameters suitable for use in designing contra-rotating blades are presented by means of formulae and graphs.

Author

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#### 06

#### ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

Includes transport of fuels by pipelines, tubes, etc., microwave power transmission, and superconducting power transmission.

A80-45534 \* # Dynamics and control of a continuum model for a solar power system. J. N. Juang (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). In: Guidance and Control Conference, Danvers, Mass., August 11-13, 1980, Collection of Technical Papers.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 163-173, 11 refs. Contract No. NAS7-100. (AIAA 80-1740)

An approach for modeling dynamic equations of motion of a plate attached with rigid bodies is presented. The equations of motion are developed using the principle of virtual work. Lagrange multipliers are used as interaction forces and/or moments to maintain prescribed constraints which is the basis of the interconnection between the plate and rigid bodies. The overall approach is unique in the sense that a continuous model described by a family of partial differential equations is established. An approximate formulation by using variational method is established yielding a solution compatible with the assumed degree of approximation. The formulation is useful particularly when parametric study of dynamic response for a satellite power system is desired. As an example, an approximate governing equation of algebraic eigenvalue problem is given for a dual microwave power transmission system. Controller design is discussed. (Author)

A80-46396 # An environmental assessment of the satellite power system reference design. N. F. Barr (U.S. Department of Energy, Satellite Power Systems Office, Washington, D.C.). In: Space Manufacturing III; Proceedings of the Fourth Conference, Princeton, N.J., May 14-17, 1979. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 441-445; Discussion, p. 446.

The paper describes an environmental assessment program which will identify and define environmental issues associated with the installation and operation of Satellite Power Systems (SPS). A joint Concept Development and Evaluation Program (CDEP) of NASA and DOE will provide a plan for ground based R&D work which will also reduce uncertainties regarding environmental impacts. Environmental problems will include: (1) microwave exposure effects on human health and ecosystems, (2) impacts of SPS launch and heat insertions on the atmosphere, and (3) effects of SPS operations on electromagnetic systems and use of the radio spectrum.

A.T.

A80-46397 # Solar power satellites - The ionospheric connection. L. M. Dunçan and J. Zinn (California, University, Los Alamos, N. Mex.). In: Space manufacturing III; Proceedings of the Fourth Conference, Princeton, N.J., May 14-17, 1979.

New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 447-454. 21 refs.

This paper reviews the ionospheric effects and associated environmental impacts which may be produced during the construction and operation of a solar power satellite system. Propellant emissions from heavy lift launch vehicles are predicted to cause wide-spread ionospheric depletions in electron and ion densities. Collisional damping of the microwave power beam in the lower ionosphere will significantly enhance the local free electron temperatures. Thermal self-focusing of the power beam in the ionosphere will excite variations in the beam power flux density and create large-scale field-aligned electron density irregularities. These large-

scale irregularities may also trigger the formation of small-scale plasma striations. Ionospheric modifications can lead to the development of potentially serious telecommunications and climate impacts. A comprehensive research program is being conducted to understand the physical interactions driving these ionospheric effects and to determine the scope and magnitude of the associated environmental impacts.

(Author)

A80-46880 # Environmental effects of space systems - A review. D. M. Rote (Argonne National Laboratory, Argonne, III.). In: Space systems and their interactions with earth's space environment.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 3-53. 58 refs. Research supported by the U.S. Department of Energy.

This review and the papers in this section focus on the effects of large space systems, primarily the Satellite Power System (SPS), on the upper atmosphere. From 56-500 km, the major contaminant sources are SPS microwave transmissions and rocket effluents. Although no significant effects have yet been found for microwave transmissions, deposition of rocket effluents causes compositional changes, most of which appear to be associated with the release of large amounts of water. From 500-36,000 km, rocket effluents and ion engine contaminants (primarily Ar(+)) could alter magnetospheric and plasmaspheric structure and dynamics. One of the major impacts of these alterations could be perturbation of Van Allen radiation belt stability, leading to changed radiation hazards to materials and personnel and to modification of high energy particle precipitation events. The ambient density falls rapidly and the potential for significant environmental alteration increases as one goes outwards from the earth's surface. And, the further from the earth's surface, the less certain our knowledge of environmental change processes is. (Author)

A80-46881 # Effects of microwave beams on the ionosphere. L. M. Duncan (California, University, Los Alamos, N. Mex.). In: Space systems and their interactions with earth's space environment.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 54-77. 20 refs. Research supported by the U.S. Department of Energy.

This is a review of the effects associated with the propagation of intense microwave beams through the ionosphere. Collisional damping of the microwave beam in the lower ionosphere will significantly enhance the local free electron temperatures. Experimental observations of this enhanced electron heating are in general agreement with the theoretical models. In addition, thermal self-focusing of electromagnetic waves in the ionosphere can produce variations in the beam power flux density and create large-scale electron density irregularities. These large-scale irregularities also may trigger the formation of small-scale plasma striations. Again, experimental results support theoretical models of this phenomenon. These investigations of the dominant physical processes involved in microwave propagation through the ionosphere are applicable to the environmental impacts assessment of the proposed solar-power satellite microwave powertransmission system. Ionospheric modifications can lead to the potentially enhanced telecommunications and climate impacts.

(Author)

A80-47562 \* Solar power satellites - The present and the future. G. D. Arndt (NASA, Johnson Space Center, Houston, Tex.). In: ITC/USA/'79; Proceedings of the International Telemetering Conference, San Diego, Calif., November 19-21, 1979.

Pittsburgh, Pa., Instrument Society of America, 1979, p. 165-181.

The present reference solar power satellite (SPS) configuration is discussed with emphasis on the microwave subsystems and possible alternatives. Other considerations, including study guidelines, system sizing tradeoffs, mass and cost projections, and environmental factors, are outlined.

V.T.

A80-48271 # Benefits arising from the use of pneumatic energy transmittal in wind-power systems. J. A. C. Kentfield (Calgary, University, Calgary, Alberta, Canada). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy

#### **06 ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION**

Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 821-827.6 refs.

A brief description is given of a new form of simple, fixed pitch, horizontal axis wind turbine suitable for the direct drive of mechanical devices such as pumps, compressors, etc. Experimentally obtained performance characteristics of the turbine are presented which show that a relatively good performance is achievable. A pneumatic transmission system suitable for use in conjunction with the new turbine is also described. Predictions of the performance of the pneumatic transmission show that it has particular advantages when used in combined wind and solar-energy conversion systems for electrical power generation. The energy conversion effectiveness of an optimized configuration is 54% when internal losses are taken into account and approximately 60% of the total energy input is thermal the remainder being shaft-power provided by the wind-turbines incorporated in the system. Advantages of pneumatic transmissions are discussed. These include, apart from overall system simplicity, the use of a non-toxic working fluid and the comparative ease with which energy storage can be provided both in the form of stored compressed air and, with solar assisted systems, thermally. (Author)

A80-48311 # Status of nuclear high temperature process heat development in the Federal Republic of Germany /coal gasification and long distance energy transport/. R. Pruschek (Gesellschaft für Hochtemperaturreaktor-Technik mbH, Bergisch Gladbach, West Germany), E. Arndt (Hochtemperatur-Reaktorbau GmbH, Mannheim, West Germany), and R. Harth (Kernforschungsanlage Jülich GmbH, Jülich, West Germany). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1074-1079. Research sponsored by the Bundesministerium für Forschung und Technologie and Nordrhein-Westfalen Minister für Wirtschaft, Mittelstand und Verkehr.

A80-48312 # High-temperature gas-cooled reactors and process heat. P. R. Kasten (Oak Ridge National Laboratory, Oak Ridge, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1101-1106. 12 refs. Contract No. W-7405-eng-26.

High-temperature gas-cooled reactors (HTGRs) are fueled with ceramic-coated microspheres of uranium and thorium oxides/ carbides embedded in graphite blocks which are cooled with helium. Promising areas of HTGR application are in cogeneration, energy transport using heat transfer salt, recovery of oils from oil shale, steam reforming of methane for chemical production, coal gasification, and in energy transfer using chemical heat pipes in the long term. Further, HTGRs could be used as the energy source for hydrogen production through thermochemical water splitting in the long term. The potential market for process heat HTGRs is 100-200 large units by about the year 2020. HTGR cogeneration plants appear attractive in those applications where new and large process energy plants are needed. Where coal is the alternative fuel, significantly reduced consumption of coal, water and land resources as well as reduced emissions of pollutants such as SO2, NOX, and CO2 result from the use of the HTGR. (Author)

A80-48313 # Design of the HTGR for process heat applications. D. L. Vrable and R. N. Quade (General Atomic Co., San Diego, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1107-1112. 6 refs. Contract No. DE-AT03-SF-71061.

The high-temperature gas-cooled reactor (HTGR) offers a unique heat source for process heat applications, since its operating temperature is substantially higher than other nuclear reactor types.

This paper discusses a design study of an advanced 842-MW(t) HTGR with a reactor outlet temperature of 850 C (1562 F), coupled with a chemical process whose product is hydrogen (or a mixture of hydrogen and carbon monoxide) generated by steam reforming of a light hydrocarbon mixture. This paper discusses the plant layout and design for the major components of the primary and secondary heat transfer systems. Typical parametric system study results illustrate the capability of a computer code developed to model the plant performance and economics. (Author)

A80-48357 \* # Power management for multi-100 KWe space systems. J. W. Mildice (General Dynamics Corp., Convair Div., San Diego, Calif.) and M. E. Valgora (NASA, Lewis Research Center, Cleveland, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1401-1405. Contract No. NAS3-21757.

This paper examines mid to late 1980s power management technology needs to support development of a general-purpose space platform, capable of supplying 100 to 250 KWe to a variety of users in LEO. To that end, a typical Shuttle-assembled and supplied space platform is described, along with a group of payloads which might reasonably be expected to use such a facility. Examination of platform and user power needs yields a set of power system requirements used to evaluate power management options for life cycle cost effectiveness. The most cost-effective AC/DC and DC systems are evaluated, specifically to develop system details which lead to technology goals including array and transmission voltage, best frequency for AC power transmission, and advantages and disadvantages of AC and DC systems for this application. Finally, system and component requirements are compared with the state of the art to identify areas where technology development is required. (Author)

A80-48506 \* # Gas distribution equipment in hydrogen service - Phase II. W. J. Jasionowski and H. D. Huang (Institute of Gas Technology, Chicago, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2295-2300. Research supported by the U.S. Department of Energy; Contract No. JPL-955447.

The hydrogen permeability of three different types of commercially available natural gas polyethylene pipes was determined. Ring tensile tests were conducted on permeability-exposed and as-received samples. Hydrogen-methane leakage experiments were also performed. The results show no selective leakage of hydrogen via Poiseuille, turbulent, or orifice flow (through leaks) on the distribution of blends of hydrogen and methane. The data collected show that the polyethylene pipe is 4 to 6 times more permeable to hydrogen than to methane.

A80-50994 # The first realistic solar energy project (Das erst realistische Sonnenenergie-Projekt). K. Kaindl and W. Lothaller. Berichte und Informationen, vol. 35, no. 4, 1980, p. 16-18. In German.

A proposed solar power satellite uses solar cells to produce electric energy which is sent to the earth as microwaves. An antenna receives the microwaves which can be converted into electric current. The satellite weighs between 35,000 and 50,000 metric tons, and the solar cells consist of silicon or gallium arsenides. The cost for development of the project is discussed, with emphasis on the share of the cost of Europe and particularly for Austria.

N80-29473# Pittsburgh Univ., Pa. HYDROGEN DISTRIBUTION AND TRANSFER IN COAL HYDROGENATION SYSTEMS Quarterly Report, Dec. 1979 - Feb. 1980

S. H. Chiang and G. E. Klinzing Mar. 1980 9 p

(Contract DE-AC22-80PC-30014) (DOE/PC-30014/1) Avail: NTIS HC A02/MF A01

Development of an in-situ H2 probe and experimental data of equilibrium distribution and rate of transfer of hydrogen in coal hydrogenation systems is proposed. Specific topics discussed include: (1) a thin nickel-membrane probe for in-situ hydrogen measurement; (2) equilibrium solubility data for hydrogen in coal liquids; (3) dynamic behavior and rate of hydrogen transfer in coal liquids and to examine the rate limiting steps of the process; (4) the physical/chemical effect due to the addition of coal on the equilibrium distribution of hydrogen in coal liquids; and (5) the rate of transfer of hydrogen between the gas phase and the condensed phase (which contains coal liquids and dissolved coal).

N80-29629# Colorado School of Mines, Golden. EXPERIMENTAL DESIGN FOR HYDRAULIC TRANSPORT RESEARCH FACILITY Final Technical Report Robert R. Faddick, ed. Dec. 1979 170 p refs (Contract ET-78-S-01-3274)

(FE-3274-1) Avail: NTIS HC A08/MF A01

A research program was to be defined for the operation of the newly constructed Hydraulic Transport Research Facility (HTRF). The program was to be designed to obtain engineering data for the design of efficient, economical, and reliable new coal hydraulic haulage systems from the mine face to the wash plant. The research program was to be completed in the shortest feasible time and at the lowest operating cost. A five year experimental design consisting of three phases was developed. After a two month calibration period, Phase 1 (first year) tests all three pipeline diameters with both a washed and unwashed coal at varying slurry concentrations. Head losses, deposition velocities, and exploratory work on flow transients constitute the test program. Phase 2 (second year) allows for implementation of the data logger for examination of particle size distribution and flow transients. Phase 2 (next three years) comprises a definitive study on transients, particle size, and studies different coals and coal-refuse mixtures. New technology is also to be examined. It is recommended that a separate analytical team be from the current contractor team to coordinate the data generated by the HTRF and develop it for industry's use.

N80-29842\* # National Aeronautics and Space Administration, Washington, D. C.

SATELLITE POWER SYSTEMS (SPS): CONCEPT DEVELOP-MENT AND EVALUATION PROGRAM: PRELIMINARY

ASSESSMENT DOE Sep. 1979 19 p refs. Sponsored by DOE

DOE/ER-0041) (NASA-TM-81142; HC A02/MF A01 CSCL 10A

A preliminary assessment of a potential Satellite Power System (SPS) is provided. The assessment includes discussion of technical and economic feasibility; the effects of microwave power transmission beams on biological, ecological, and electromagnetic systems; the impact of SPS construction, deployment, and operations on the biosphere and on society; and the merits of SPS compared to other future energy alternatives.

N80-29845\*# General Dynamics/Convair, San Diego, Calif. STUDY OF POWER MANAGEMENT TECHNOLOGY FOR ORBITAL MULTI-100KWe APPLICATIONS. VOLUME 3: REQUIREMENTS

J. W. Mildice 15 Jul. 1980 37 p refs 3 Vol. (Contract NAS3-21757)

(NASA-CR-159834; GDC-ASP-80-015) Avail: NTIS HC A03/MF A01 CSCL 10B

Mid to late 1980's power management technology needs to support development of a general purpose space platform, capable of suplying 100 to 250 KWe to a variety of users in low Earth orbit are examined. A typical, shuttle assembled and supplied space platform is illustred, along with a group of payloads which might reasonably be expected to use such a facility. Examination of platform and user power needs yields a set of power requirements used to evaluate power management options for life cycle cost effectivness. The most cost effective ac/dc and dc systems are evaluated, specifically to develop system details which lead to technology goals, including: array and

transmission voltages, best frequency for ac power transmission, and advantages and disadvantages of ac and dc systems for this application. System and component requirements are compared with the state-of-the-art to identify areas where technological development is required.

N80-30656# Los Alamos Scientific Lab., N. Mex. THE dc SUPERCONDUCTING POWER TRANSMISSION LINE PROJECT AT LASL: US DOE DIVISION OF ELECTRIC ENERGY SYSTEMS Final Progress Report, 1 Nov. 1972 -30 Sep. 1979

F. J. Edeskuty, comp. Apr. 1980 270 p refs (Contract W-7405-eng-36)

(LA-8323-PR; FPR-24) Avail: NTIS HC A12/MF A01

Plans for the development of a high capacity, underground dc superconducting power transmission line (dc SPTL) that uses Nb3Sn superconducting wires cooled to 12 K by gaseous helium are discussed. The dc SPTL offers a number of potential advantages including: no system stability or load flow constraints, lower short circuit current levels than any other transmission system; reactive compensation is not needed; no dielectric losses are exhibited; conductor losses are negligible; and the dc SPTL cable has the highest efficiency and current density capability of all cables. The requirement for such high power transmission capability is still several decades in the future and the SPTL technology is considered a high risk undertaking. Activities in electrical engineering, cryogenic engineering, and superconductor design are summarized.

N80-30891\*# Rice Univ., Houston, Tex.
SOLAR POWER SATELLITE OFFSHORE RECTENNA STUDY

May 1980 284 p refs Prepared in cooperation with Brown and Root Development, Inc., Houston, Tex. and Little (Arthur D.), Inc., Cambridge, Mass.

(Contract NAS8-33023)

(NASA-CR-161543) Avail: NTIS HC A13/MF A01 CSCL

Offshore rectennas are feasible and cost competitive with land rectennas but the type of rectenna suitable for offshore use is quite different from that specified in the present reference system. A nonground plane design minimizes the weight and greatly reduces the number of costly support towers. This perferred design is an antenna array consisting of individually encapsulated dipoles with reflectors or tagis supported on feed wires. Such a 5 GW rectenna could be built at a 50 m water depth site to withstand hurricane, winter storm, and icing conditions for a one time cost of \$5.7 billion. Subsequent units would be about 1.3 less expensive. More benign and more shallow water sites would result in substantially lower costs. The major advantage of an offshore rectenna is the removal of microwave radiation from populated areas.

N80-30900\*# Rockwell International Corp., Downey, Calif. SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 7: SYSTEM/SUBSYSTEM REQUIRE-MENTS DATA BOOK Final Report

G. M. Hanley Sep. 1980 120 p (Contract NAS8-32475)

(NASA-CR-3324;

SSD-79-0010-7-Vol-7) Avail:

NTIS

HC A06/MF A01 CSCL 10A

The identified subsystem/systems requirements are defined for the solar power satellites. Recommendations for alternate approaches which may represent improved design features are presented.

N80-30901\*# Rockwell International Corp., Downey, Calif. SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY, VOLUME 1: EXECUTIVE SUMMARY Final Report

G. M. Hanley Washington NASA Sep. 1980 67 p refs

(Contract NAS8-32475)

SSD-79-0010-1-Vol-1) (NASA-CR-3317; NTIS Avail: HC A04/MF A01 CSCL 10A

System definition studies resulted in a further definition of the reference system using gallium arsenide solar arrays, analysis

NTIS

#### 06 ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

of alternative subsystem options for the reference concept. preliminary solid state microwave concept studies, and an environmental analysis of laser transmission systems. The special emphasis studies concentrated on satellite construction, satellite construction base definition, satellite construction base construction, and rectenna construction. Major emphasis in the transportation studies was put on definition of a two stage parallel burn, vertical takeoff/horizontal landing concept. The electric orbit transfer vehicle was defined in greater detail. Program definition included cost analyses and schedule definition.

N80-31268\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

A STUDY OF A SPACE COMMUNICATION SYSTEM FOR THE CONTROL AND MONITORING OF THE ELECTRIC DISTRIBUTION SYSTEM. VOLUME 1: SUMMARY Final

A. Vaisnys May 1980 54 p refs (Contracts NAS7-100; DE-AI01-79ET-29372) (NASA-CR-163477; JPL-Pub-80-48-Vol-1) NTIS HC A04/MF A01 CSCL 13F

It is technically feasible to design a satellite communication system to serve the United States electric utility industry's needs relative to load management, real-time operations management, remote meter reading, and to determine the costs of various elements of the system. A definition of distribution control and monitoring functions is given. Associated communications traffic is quantified. A baseline conceptual design in terms of operating capability and equipment is described, important factors to be considered in designing a system are examined, and preliminary cost data are provided. Factors associated with implementation are discussed and conclusions and recommendations are listed. R.K.G.

N80-31890\*# Rockwell International Corp., Downey, Calif. SATELLITE POWER SYSTEMS (SPS) CONCEPT DEFINITION STUDY. VOLUME 2, PART 1: SYSTEM ENGINEERING Final Report

G. M. Hanley Washington Sep. 1980 258 p 7 Vol. (Contract NAS8-32475)

SSD-79-0010-2-1) (NASA-CR-3318; Avail: NTIS HC A12/MF A01 CSCL 10A

Top level trade studies are presented, including comparison of solid state and klystron concepts, higher concentration on the solar cells, composite and aluminum structure, and several variations to the reference concept. Detailed trade studies are presented in each of the subsystem areas (solar array, power distribution, structures, thermal control, attitude control and stationkeeping, microwave transmission, and ground receiving station). A description of the selected point design is also presented. Author

N80-31923# California Univ., Berkeley. Lawrence Berkeley Lab. Information Methodology Research Project.

MATERIAL-FLOW DATA STRUCTURES AS A BASIS FOR ENERGY INFORMATION SYSTEM DESIGN

V. V. Krishnan and D. F. Cahn Apr. 1980 20 p refs Presented at 9th Mid-Yr. Meeting of the Am. Soc. for Inform. Sci., Pittsburgh, 15-17 May 1980

Avail:

(Contract W-7405-eng-48)

CONF-800529-3) (LBL-10248:

HC A02/MF A01

The US petroleum supply and distribution system is analyzed. Data structures conducive to information system design are developed. Quantized petroleum flows among restricted channels in the distribution net form the basis of the data structure. The resultant vectorial representations provide a direct link between conceptual models of system function and information system implementations. Simultaneously, they ease otherwise difficult

N80-32789# Brookhaven National Lab., Upton, N. Y. BENDING BEHAVIOR OF LAPPED PLASTIC EHV CABLES G. H. Morgan and A. C. Muller 1980 6 p refs Presented at

problems such as data validation and error isolation.

1980 Intern. Symp. on Elec. Insulation, Boston, 9-11 Jun. 1980

(Contract DE-AC02-76CH-00016) (BNL-27331) Avail: NTIS HC A02/MF A01

One of the factors delaying the development of lapped polymeric cables was their reputed poor bending characteristics. Complementary programs were begun several years ago to mathematically model the bending of synthetic tape cables and to develop novel plastic tapes designed to have moduli more favorable to bending. A series of bend tests was recently completed to evaluate the bending performance of several tapes developed for use in experimental superconducting cables. The program is discussed and the results of the bend tests are summarized.

N80-33904# European Space Technology Center, Noordwijk (Netherlands). Systems Engineering Dept. SATELLITE POWER SYSTEMS: STATUS AND PLANNED

ACTIVITIES D. Kassing In ESA Photovoltaic Generators in Space Jun. 1980 p 239-244 refs

Avail: NTIS HC A12/MF A01; ESA, Paris FF 80

The general progress in satellite power system (SPS) system definition and assessment activities to date is summarized, and selected technical issues identified as being crucial for the photovoltaic solar energy conversion subsystem of the reference concept are reviewed. The requirements of the photovoltaic subsystem are discussed with respect to the alternative power transmission options studied by NASA since October 1978, particularly solid state microwave devices and laser. A summary is given of the system impact assessment and European SPS Activities. Author (ESA)

# 07 ENERGY STORAGE

Includes flywheels, heat storage, underground air storage, compressed air, storage batteries, and electric hybrid vehicles.

A80-44241 Large-scale electrical energy storage. B. J. Davidson, A. B. Hart, B. J. Maddock, P. J. Worthington (Central Electricity Generating Board, Central Electricity Research Laboratones, Leatherhead, Surrey, England), I. Glendenning, R. D. Moffitt (Central Electricity Generating Board, Marchwood Engineering Laboratories, Marchwood, Hants., England), R. D. Harman, V. G. Newman, T. F. Smith, and J. K. Wright (Central Electricity Generating Board, London, England). IEE Proceedings, Part A Physical Science, Measurement and Instrumentation, Management and Education, Reviews, vol. 127, pt. A, no. 6, July 1980, p. 345-385. 111 refs.

A wide range of large-scale electric energy storages for future power generation is reviewed, and problems and performance characteristics are summarized. Consideration is given to pumped compressed-air, thermal-energy, electrochemical battery, and superconducting magnetic energy storages and flywheels. The relative advantages and disadvantages of various technical possibilities are discussed.

A80-45315 The layer perovskites as thermal energy storage systems. V. Busico, C. Carfagna, V. Salerno, and M. Vacatello (Napoli, Università, Naples, Italy). Solar Energy, vol. 24, no. 6, 1980, p. 575-579. 15 refs. Research supported by the Consiglio Nazionale delle Ricerche.

A series of compounds of the general formula (n-CnH2n plus 1NH3)2MCI4 (where M is a divalent metal atom and n is in the range of 8-18) undergoing high enthalpy reversible solid-solid phase transitions is considered. Although their transition enthalpy values are lower than those of the corresponding normal paraffins, the advantage of remaining solid after the phase change, together with other properties, makes these compounds of potential interest in the field of thermal energy storage systems. (Author)

A80-45725 # Numerical simulation of dual-media thermal energy storage systems. R. J. Gross, C. E. Hickox, and C. E. Hackett (Sandia Laboratories, Albuquerque, N. Mex.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 6-8, 1979, ASME Paper 79-HT-35. 11 p. 20 refs. Members, \$1.50; nonmembers, \$3.00. Contract No. DE-AC04-76DP-00789.

A finite-difference, predictor-corrector, numerical technique originated by MacCormack is used to solve for fluid and solid temperature distributions in one-dimensional flow through a finite length packed bed. The method allows for temperature dependent properties, time varying inlet conditions and nonuniform initial conditions. Computed results agree with the classical Schumann model to within 1% in simulations which exhibit thermal gradients as large as 310 C/m. Additional examples illustrate the attractive characteristics of the method, namely its accuracy, flexibility, ease of implementation, and computational efficiency. (Author)

A80-45726 # Transient response of a latent heat storage unit - An analytical and experimental investigation. T. F. Green (Radian Corp., Austin, Tex.) and G. C. Vliet (Texas, University, Austin, Tex.). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, 18th, San Diego, Calif., Aug. 6-8, 1979, ASME Paper 79-HT-36. 10 p. 8 refs. Members, \$1.50; nonmembers, \$3.00.

An analytical and experimental investigation of the transient thermal response of a latent heat storage unit is presented. Emphasis is placed on characterization of an entire storage unit rather than a single constituent storage element. In the analysis, two coupled governing partial differential equations that describe the model are derived and then nondimensionalized and solved numerically. Analytical results are presented in terms of phase change material (PCM) quality and heat transfer fluid (HTF) temperature. These results illustrate that three dimensionless characterization parameters can be used to predict the storage unit response. A comparison of experimental and analytical results shows that while the analysis nominally predicts slightly conservative results, it appears to be a very promising tool for designing and sizing latent heat storage units. (Author)

A80-45826 # Computer aided optimal design of compressed air energy storage systems. F. W. Ahrens (Argonne National Laboratory, Argonne, III.), A. Sharma (Illinois, University, Chicago, III.), and K. M. Ragsdell (Purdue University, West Lafayette, Ind.). ASME, Transactions, Journal of Mechanical Design, vol. 102, July 1980, p. 437-445. 23 refs. Research supported by the U.S. Department of Energy, Argonne National Laboratory, Purdue Research Foundation, and Purdue University.

An automated procedure for the design of Compressed Air Energy Storage (CAES) systems is presented. The procedure relies upon modern nonlinear programming algorithms, decomposition theory, and numerical models of the various system components. Two modern optimization methods are employed; BIAS, a Method of Multipliers code and OPT, a Generalized Reduced Gradient code. The procedure is demonstrated by the design of a CAES facility employing the Media, Illinois Galesville aquifer as the reservoir. The methods employed produced significant reduction in capital and operating cost, and in number of aquifer wells required. (Author)

A80-46414 \* # Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis. S. M. Sidik, H. F. Leibecki, and J. M. Bozek (NASA, Lewis Research Center, Cleveland, Ohio). American Statistical Association, Annual Meeting, Houston, Tex., Aug. 11-14, 1980, Paper. 46 p. 10 refs.

The data analysis of cycles to failure of silver-zinc electrochemical cells with competing failure modes is presented. The test ran 129 cells through charge-discharge cycles until failure; preliminary data analysis consisted of response surface estimate of life. Batteries fail through low voltage condition and an internal shorting condition; a competing failure modes analysis was made using maximum likelihood estimation for the extreme value life distribution. Extensive residual plotting and probability plotting were used to verify data quality and selection of model.

A.T.

A80-47137 Lead-acid battery expander. I - Electrochemical evaluation techniques. B. K. Mahato (Globe-Union, Inc., Milwaukee, Wis.). (Electrochemical Society, International Conference on Chemical Vapor Deposition, 7th, Los Angeles, Calif., Oct. 14-19, 1979.) Electrochemical Society, Journal, vol. 127, Aug. 1980, p. 1679-1687. 39 refs. U.S. Department of Energy Contract No. 31-109-38-4205.

The role of lignosulfonate constituent of the lead-acid battery expander on the negative electrode performance is analyzed. Two quantitative electrochemical techniques have been developed to monitor the expander activities on constant current discharge and capacity maintenance behavior of the electrode during cycling. Both these techniques are based on small electrodes and proved effective in evaluating expander candidate materials outside the test battery. Test results agree closely with the reported expander's influence on the pasted electrode. The plausible mechanisms of expander action during high rate discharge and deep discharge cycling are elucidated. (Author)

A80-47391 # Selection of the optimal design parameters of an aircraft flywheel-type power supply system (O vybore optimal'nykh proektnykh parametrov makhovichnoi energosistemy letatel'nogo apparata). V. G. Dorofeev, N. F. Sviridenko, and A. F. Danchul. Samoletostroenie - Tekhnika Vozdushnogo Flota, no. 46, 1979, p. 9-13. In Russian.

#### **07 ENERGY STORAGE**

An approximate method is proposed for determining the required flywheel moment of inertia for a power supply system consisting of a flywheel, a variable-speed gear, and a current generator of stable frequency. The analytical relations derived can be used to calculate the optimal gear ratio that minimizes the required moment of inertia and, hence, the flywheel mass.

V.P.

A80-47454 # Rotating strength of laminated composite discs. S. Tsuda (Sumitomo Heavy Industries, Ltd., Japan), E. Shiratori, and K. Ikegami (Tokyo Institute of Technology, Yokohama, Japan). JSME, Bulletin, vol. 23, June 1980, p. 822-830. 12 refs.

The rotating strength of a circumferentially fiber-reinforced disc is limited by the radial strength of disc material. To increase the radial strength of the disc, additional radial fiber-reinforcement tangential to the inner hole and lamination-reinforcement with in-plane isotropy of discs are studied theoretically and experimentally. Discs used in the experiments are made of glass fibers and epoxy resin. Circumferentially reinforced discs are molded by the filament winding method of glass robings, and isotropic in-plane discs are molded by the handlay-up method of glass robing clothes. A method of reinforcement of such discs by the lamination of glass robing clothes is proposed.

A80-47598 Heat storage utilizing Thermol 81 Energy Storage. S. Campbell. In: Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers.

Atlanta, Ga., Fairmont Press, Inc., 1980, p. 353, 354.

A new heat storage device, Thermol 81 Energy Storage Rods, is presented. The device consists of 3-1/2 in. diameter, 6 foot long ultrahigh molecular weight polyethylene tubes filled with a phase change compound which has a base of calcium chloride. When the rods reach a temperature of 81 F they will store 2460 Btu per rod at that temperature. Storage then changes from latent to specific heat at 0.53 Btu per degree temperature per pound of phase change material. Some applications of Thermol 81 are discussed, including industrial and commercial heat reclamation, passive solar homes, passive hybrid applications, and a solar forced air system.

A80-48001 # Transient thermal analysis of phase change thermal energy storage systems. B. Yimer, J. N. Crisp (Kansas, University, Lawrence, Kan.), and E. T. Mahefkey (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). American Society of Mechanical Engineers and American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-2. 11 p. 25 refs. Members, \$1.50; nonmembers, \$3.00.

An analytical model was developed to determine the temperature distribution and interface location of a phase change material contained in a cylindrical annulus in an energy storage system. The model handles one- and two-dimensional problems with temperature dependent properties (except density) subject to rather general time varying boundary conditions. Additionally, the thermal energy storage material may include fins and may be above the fusion temperature initially. The governing equations were developed using the enthalpy approach. The Gauss-Seidel iterative method with successive over-relaxtion was used to numerically solve the resulting nonlinear simultaneous finite-difference equations. The accuracy of the enthalpy approach and the numerical solutions was evaluated by two independent methods. Agreement for both cases was excellent. Using the analytical model, results were obtained for various existing thermal energy storage systems and were compared and correlated with available experimental data. Overall agreement was excellent.

(Author)

A80-48009 # Performance of storage walls with highly conductive covering plates and connecting fins. J. K. E. Ortega, C. E. Bingham, and J. M. Connolly (Solar Energy Research Institute, Golden, Colo.). American Society of Mechanical Engineers and

American Institute of Chemical Engineers, Joint National Heat Transfer Conference, Orlando, Fla., July 27-30, 1980, ASME Paper 80-HT-18. 7 p. Members, \$1.50; nonmembers, \$3.00.

The thermal behavior of a storage wall, constructed of concrete with highly conductive covering plates and connecting vertical fins, is investigated. The results demonstrate that, during the charging mode, the amount of energy released from the front surface is significantly reduced. A portion of the saved energy is stored for future discharge, but a large portion is transferred to the back surface and released. A selective front surface further reduces the energy released from the front surface, and this energy is stored. By properly selecting the fin spacing, plate-fin thickness, and plate-fin thermal conductivity, the rate and direction of thermal discharge can be controlled. The improved heat transfer capability and added thermal control provide new alternatives for interzonal heat transfer and multizone passive building designs. (Author)

A80-48125 Electric vehicles - Finally a reality. G. Greenberg, Energy, vol. 5, Summer 1980, p. 10-12.

General problems of electric vehicle production are discussed. Advantages and disadvantages of different types of batteries are pointed out, and electric vehicle manufacturers are enumerated. S.S.

A80-48180 \* # A new method of efficient heat transfer and storage at very high temperatures. D. Shaw, A. P. Bruckner, and A. Hertzberg (Washington, University, Seattle, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 125-132. 21 refs. Research supported by the University of Washington; Grant No. NAG3-16.

A unique, high temperature (1000-2000 K) continuously operating capacitive heat exchanger system is described. The system transfers heat from a combustion or solar furnace to a working gas by means of a circulating high temperature molten refractory. A uniform aggregate of beads of a glass-like refractory is injected into the furnace volume. The aggregate is melted and piped to a heat exchanger where it is sprayed through a counter-flowing, high pressure working gas. The refractory droplets transfer their heat to the gas, undergoing a phase change into the solid bead state. The resulting high temperature gas is used to drive a suitable high efficiency heat engine. The solidified refractory beads are delivered back to the furnace and melted to continue the cycle. This approach avoids the important temperature limitations of conventional tubetype heat exchangers, giving rise to the potential of converting heat energy into useful work at considerably higher efficiencies than currently attainable and of storing energy at high thermodynamic potential.

A80-48188 # Recent progress in lithium/iron sulfide battery development. D. L. Barney, R. K. Steunenberg, and A. A. Chilenskas (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 198-204. 24 refs. Research sponsored by the U.S. Department of Energy.

A joint effort by Argonne National Laboratory (ANL) and industrial subcontractors is aimed at the development of high-temperature lithium/iron sulfide batteries for electric-vehicle propulsion and stationary energy storage. The battery cells have lithium-alloy (Li-Al or Li-Si) negative electrodes, iron sulfide (FeS or FeS2) positive electrodes, and molten LiCl-KCI electrolyte. A 40 kW-hr electric vehicle battery, designated as Mark IA, was fabricated in 1979. During startup heating, a short circuit developed in one of the modules, causing a progressive failure of all the cells in the module. Various improvements are being made in the cells and battery hardware to eliminate the potential failure mechanisms. In the cell

development effort, multiplate cells having three positive and four negative electrodes have been tested successfully. In the battery development, work is in progress on thin, high-efficiency thermal insulation to be used in the battery containment vessel. (Author)

A80-48189 # Cycle life studies of LIAI/FeS cells using BN felt separators. F. J. Martino, E. C. Gay, and H. Shimotake (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 205-210. 6 refs. Research sponsored by the U.S. Department of Energy.

The paper describes the development of LiAl/FeS cells capable of extended operation with little cell-capacity decline. Tests of bicells which contain one positive and two negative electrodes and of multiplate cells from the Mark IA program indicate that cell capacity loss is attributable to several causes. Current studies include the effect of electrolyte lithium-ion concentration on capacity stability, positive electrode theoretical capacity density, and negative-to-positive theoretical capacity ratio; a variety of engineering scale (300 cu cm) cells are tested to investigate these factors.

A.T.

A80-48190 # Optimization studies of lithium/iron sulfide cells for electric vehicle applications. E. C. Gay, W. E. Miller, and F. J. Martino (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1 New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 211-217. Research sponsored by the U.S. Department of Energy.

A study is presented of the lithium-aluminum/iron sulfide cells for electric vehicle propulsion to identify the best design to meet battery performance requirements. Empirical equations which relate physical and chemical properties of the cell and the mode of cell operation with the specific energy as a function of cycle life were used to predict the specific energy up to 800 cycles at 440-480 C in 84 Li-Al/FeS cell designs. The positive-electrode thickness, volume fraction of salt in the positive electrode, and positive-electrode loading density were investigated. It was shown that the optimal specific energy will be achieved by a cell with thin electrodes, a negative-to-positive capacity ratio greater than one, and an initial capacity loading density of 1.4 to 1.6 A-hr/cu cm.

A.T.

A80-48191 # New approach to electrode current collection for LiAl/iron sulfide cells. T. D. Kaun, P. F. Eshman, and W. E. Miller (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 218-223. 6 refs. Research sponsored by the U.S. Department of Energy.

The paper presents a new method of electrode current collection for LiAl/FeS cells with molten LiCl-KCl electrolyte. Perforated metal sheet with 35-45% open area at the electrode face is the primary current collector and a durable electrode container. A perforated sheet electrode separator interface can provide support to a fragile boron nitride felt electrode separator and also accommodates electrode expansion. Test cells were fabricated with carbon-bonded FeS positive electrodes, cold-pressed LiAl negative electrodes and a LiCl-KCl electrolyte; their tests show that the facial current collector maintains high electrode performance, with improvement of in-cell power due to reduced cell resistance. In a two positive-plate cell, 86% positive electrode utilization was obtained at the C/4 hr rate, with cell specific power up to 155 W/kg at 95% state of charge.

A80-48192 # Development of a tubular lithium-iron sulfide cell. Y. W. Park (Korea Institute of Science and Technology, Seoul, South Korea) and H. Shimotake. In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engi

neering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 224-227. 6 refs. Research sponsored by Korea Institute of Science and Technology.

The paper describes Li/FeS tubular cell designs in which a cylindrical electrode surrounded by an annular shaped electrode of opposite polarity was adopted to produce low-cost cells such as LeClanche and Ni-Cd cells. Central, cylindrical LiAI negative electrodes surrounded by FeS positive electrodes were electrically isolated by a ceramic MgO powder separator containing a LiCl-KCl electrolyte mixture; the positive and negative electrodes were assembled in the charged state partly in air at room temperature. Mixtures of active material and electrolyte were pressed in semi-hermetically sealed dies to form the electrode plaque. The cell test results indicate that simply fabricated low-cost high performance cells can be made using the tubular cell design.

A80-48193 # Scaling up of bipolar lithium/iron disulfide cells. T. G. Bradley (GM Research Laboratories, Warren, Mich.). In: Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 228-232. 5 refs.

The paper describes the performance and cycle life of large bipolar Li/FeS2 cells for electric vehicle batteries. The 48 at.% Li-Al alloy or 79 at.% Li-Si alloy/LiCl-KCl eutectic cells with boron nitride/FeS2 cloth of 0.68 kC/sq cm were operated at 430 C in a helium glove box by charging and discharging at constant current densities of 15-50 mA/sq cm. The results showed a capacity density of 0.45 kC/sq cm after 500 cycles and 8400 hr of operation, with the final discharge rate of 0.1 mA/sq cm. Compressive force increased the self-discharge rate and decreased the electrical resistance and the thickness of the cell.

A80-48194 \* # Energy conservation and environmental benefits of thermal energy storage systems in the pulp and paper industry. H. Edde (Howard Edde, Inc., Bellevue, Wash.) and M. W. Dietrich (NASA, Lewis Research Center, Cleveland, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 239-242. 7 refs. Contract No. DEN3-190.

A80-48195 # Chemical Energy Storage for Solar Thermal Electric Conversion. R. D. Smith (Rocket Research Co., Redmond, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 243-247. 6 refs. Research supported by the U.S. Department of Energy and NSF.

The technical and economic aspects of using reversible chemical reactions to store energy in Solar Thermal Electric Conversion (STEC) facilities have been studied. The paper describes the identification of nine promising chemical reactions from a list of over 550 candidates, preliminary process designs of energy storage subsystems based on these nine reactions, and comparison of cost and performance estimates based on these designs. The Chemical Energy Storage (CES) subsystems were designed for large (100 MWe), central receiver STEC systems, with storage output temperatures for different storage subsystems ranging from 588 K to 1,310 K. All CES processes were designed for performance requirements identified in previous work as typical of autonomous (100 percent solar) STEC operation. Storage round-trip thermal efficiencies for the reactions studied ranged from 20 to 50 percent; power-related unit costs varied between 500,000 and 100,000 S/MWt maximum storage charging rate; and energy-related unit costs varied between (Author) 14,000 and 51,000 \$/MWe-hr storage capacity.

A80-48197 # Thermal energy storage using Glauber's salt Improved storage capacity with thermal cycling. S. B. Marks (Delaware, University, Newark, Del.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 259-261. 7 refs.

Calorimetric testing of a Glauber's salt phase change material has been performed as a function of thermal cycling. The material, thickened with attapulgite clay, shows a decline in its thermal energy storage capacity with cycling. Possible mechanisms for the decline are hypothesized and tested. It is shown that a significant increase in the energy storage capacity with cycling can be achieved by controlling the size of crystals of sodium sulfate and Glauber's salt.

(Author)

A80-48234 # Advanced battery development at General Electric. J. A. Asher and J. A. Bast (General Electric Co., Schenectady, N.Y.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 550-553. 5 refs. Research supported by the Electric Power Research Institute.

The status of a sodium-sulfur battery development program sponsored by General Electric is reviewed with reference to the component development and scale-up, cell safety and performance testing, and battery system design. To date, more than 500 small laboratory cells with a theoretical capacity of 16 Ah have been tested; these cells routinely exceed lifetimes of 700 cycles, the maximum (ifetime being over 1800 cycles. All major components have gone through scale-up to a B-series cell design. The B-series has a theoretical capacity of 240 Ah. A further scale-up to a commercial prototype size (C-series) is now being pursued.

A80-48235 # Sodium-sulfur load leveling battery system. H. J. Haskins and C. R. Halbach (Ford Aerospace and Communications Corp., Aeronutronic Div., Newport Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 554-560. Contract No. DE-AM02-79CH-10012.

High-temperature sodium-sulfur cells are being developed by Ford Aerospace and Communications Corporation for load-leveling and electric-vehicle battery applications. A conceptual design of a 100-MWh load-leveling battery is described. The concept adapts well to meet the requirements for large stationary energy storage batteries since reactants, electrolyte, and structural materials are abundant and economically available. A typical 100-MWh battery configuration includes five unit battery enclosures, each approximately 20 ft wide by 20 ft high by 80 ft long. The 1800-ton battery interfaces with an electric utility grid through a reversible power converter. A discharge cycle typically occurs about midday during peak power demands, while charging occurs at night. Load-leveling battery cells are being developed to have a service lifetime of at least 10 years and 2500 discharge/charge cycles. A tradeoff exists between the installation of increased initial capacity within the battery and field maintenance requirements. Effects of cell redundancy and reliability on the battery system sizing and performance are discussed. Various system considerations are discussed, including thermal control for 350 C service, charge control, bus bars and fusing, and cell packaging.

(Author)

A80-48236 # Volume optimization of sodium-sulfur batteries using various advanced cell concepts. M. Mikkor (Ford Motor Co., Dearborn, Mich.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 561-568, Contract No. DE-AM02-79CH-10012.

Sodium-sulfur batteries made up from different cell configurations are evaluated in terms of projected volumetric and gravimetric energy density. It is shown that batteries made with multiplate cells and cells using concentric cylindrical electrolytes offer significant potential increases in the volume and weight energy density: the gains could be as high as 40-50% over cylindrical cell batteries. However, for near term, multitube cells are the most practical ones to build. They have good heat dissipation characteristics, the electrolytes are available, and the potential volume/weight gains are 36/20%.

A80-48237 # A new rechargeable high voltage low temperature molten salt cell. G. Mamantov, R. Marassi, Y. Ogata, M. Matsunaga, and J. P. Wiaux (Tennessee, University, Knoxville, Tenn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 569-574. 37 refs. Research supported by the University of California; Contract No. EY-76-S-05-5053.

The use of tetravalent sulfur as positive electrode active material dissolved in AlCl3-NaCl melts in laboratory cells with a sodium negative electrode is discussed. The cell operates in the temperature range 180-250 C and has an open-circuit voltage of 4.2 V. In the experiments, the polarization decreased with increasing temperature. The plots of the percent utilization, energy efficiency, and energy density in relation to the current density are presented.

A80-48238 # Sodium-sulfur-aluminum chloride cells. J. J. Auborn and S. M. Granstaff, Jr. (Bell Telephone Laboratories, Inc., Murray Hill, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 575-580. 19 refs,

Secondary cells with molten sodium anodes and solid electrolytes employing catholytes comprised of sulfur monochloride, sulfur and aluminum chloride have exhibited specific energies in excess of 200 WH/kg reactants and one continues to cycle well past 200 deep charge-discharge cycles at moderate temperature (175 C) on a 2.7 volt plateau. Several other voltage plateaus exist due to the presence of stable sulfur species in oxidation states ranging from +6 to -2 affording some degree of overcharge and overdischarge protection. These cells operate reversibly in a basic solution at moderate temperature and may overcome the corrosion problems which slowed the development of both the well-known high temperature (350 C) sodium-sulfur cell and a proposed sodium-SCI4 AICI3 cell operating in an acidic molten salt solution at 225 C. (Author)

A80-48239 # Calcium/iron disulfide secondary cells. L. E. Ross, S. K. Preto, N. C. Otto, C. C. Sy, and M. F. Roche (Argonne National Laboratory, Argonne, III.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 581-585. 11 refs. Research sponsored by the U.S. Department of Energy.

To date, Ga-Si/FeS2 cells have achieved a specific energy of 67 W-hr/kg at the 5-hr rate (93 W-hr/kg at low rates). Post-test examinations of such cells have indicated that the BN-felt separator is degraded by reaction with the compound Ca2Si, which is present near full charge. Alternatives to the Ca-Si negative electrode are presently being developed to overcome this problem. (Author)

A80-48240 \* # Study of thermal energy storage using fluidized bed heat exchangers. T. E. Weast, L. J. Shannon, and K. P. Ananth (Midwest Research Institute, Kansas City, Mo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1. New York, American Institute

of Aeronautics and Astronautics, Inc., 1980, p. 619-623. Contract No. DEN3-96.

The technical and economic feasibility of fluid bed heat exchangers (FBHX) for thermal energy storage (TES) in waste heat recovery applications is assessed by analysis of two selected conceptual systems, the rotary cement kiln and the electric arc furnace. It is shown that the inclusion of TES in the energy recovery system requires that the difference in off-peak and on-peak energy rates be large enough so that the value of the recovered energy exceeds the value of the stored energy by a wide enough margin to offset parasitic power and thermal losses. Escalation of on-peak energy rates due to fuel shortages could make the FBHX/TES applications economically attractive in the future.

A80-48241 # A model direct contact heat transfer for latent heat energy storage. M. E. Cease (Solar Energy Research Institute, Golden, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 624-629. 16 refs.

A model of direct contact heat transfer for latent heat storage has been developed based on existing data on drop formation, rise velocity, and heat transfer. Good agreement is achieved between the circulating-drop model and the available experimental data in the early melting region. However because of the model sensitivity to the estimates used for drop size, continuous phase viscosity, and interfacial tension, additional experimental research is required to conclusively validate the model.

V.L.

A80-48272 # Analysis of small, nonconventional electric power systems for remote site applications. L. I. Boehman, L. A. Anderson (Dayton, University, Dayton, Ohio), J. N. Crisp (Kansas, University, Lawrence, Kan.), J. D. Pinson (San Jose State University, San Jose, Calif.), and W. S. Bishop (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 1.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 828-834. Contract No. F33615-77-C-2004.

Electric power systems with energy conversion by wind, solar, and hybrid wind-solar configurations and energy storage in flywheels, hydrogen, batteries and thermal devices are considered. Relative performance, cost, availability, and reliability are compared for the conceptual systems. A modular configuration with two 8 kW wind energy converters and sealed lead acid batteries is analyzed in detail for a remote site military application in northern Alaska. The system analyzed can provide 5 kW on a continuous basis with 5.6 meters per sec average wind velocity and have 12 hours of reserve capacity stored in the battery energy storage system. (Author)

A80-48288 # Development status and utility of the sulfuric acid chemical heat pump/chemical energy storage system. E. C. Clark and D. K. Carlson (Rocket Research Co., Redmond, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 926-931. 6 refs.

The sulfuric acid and water chemical heat pump/chemical energy storage system (CHP/CES) promises to be a cost effective means of providing heat pumping and energy storage over a wide range of design conditions. It is suitable for both heating and cooling applications. An engineering model CHP/CES system has been designed, fabricated, and tested closed loop under U.S. Department of Energy (DOE) funding with a nominal 25,000 Btu/hr charge and discharge rate and 300,000 Btu storage capacity. Preliminary testing of commercial grade acid plumbing and valves is complete with no equipment failures. Testing is continuing to study component life and system configuration. Design requirements for commercializa-

tion have been investigated, and a survey made of applicable building codes. A preliminary economic study of an industrial heat pump application determined the capital equipment and installation costs can be repaid in less than 2 years. Currently, a large-scale verification test unit (VTU) is being designed. Fabrication and closed-loop demonstration are scheduled to occur in 1981. (Author)

A80-48307 \* # Design and performance of the International Sun-Earth Explorer power systems. A. F. Obenschain and A. P. Ruitberg (NASA, Goddard Space Flight Center, Greenbelt, Md.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1051-1057.

The launches of the International Sun-Earth Explorers in October 1977 (ISEE-A) and August 1978 (ISEE-C) marked the first successful implementation of an electrostatically clean spacecraft design on a US-built satellite. The power subsystem design selected was required to operate without induced or coupled electromagnetic interference while meeting the criteria of low cost, low weight (with the resulting removal of almost all redundancy), modular construction techniques, long life (more than 3 years), and maximum utilization of previously qualified/flown designs. To save money, both the ISEE-A and -C power subsystem designs had to be identical even though the two missions are flown in vastly different orbits. Additionally, the requirement for a three year mission utilizing a single silver-cadmium battery had never been imposed before. A power subsystem configuration which met all of the specified requirements was developed. Excellent correlation between preflightand actual flight performance is demonstrated.

A80-48310 # Mission analysis of the P78-2 power subsystem after one year of operation. J. Rink and J. Lear (Martin Marietta Aerospace, Denver, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1070-1073.

The paper presents an operational mission analysis of the electrical power system of the Air Force P78-2 spacecraft after one year of operation. The analysis includes the solar array and full shunt regulator, the charge control, the 8-Ah Ni-Cd batteries with a polypropylene separator, and the cabling criteria. The spacecraft features ground station control of the battery charging and discharging to enhance the reliability and operating flexibility. Particular attention is given to the reduction of EMI by backwiring the solar array and wiring the battery cells to minimize magnetic fields. The spacecraft has been in orbit for more than one year with no technical problems.

A80-48325 # Status of electrochemical energy storage systems for electric vehicle, solar, and electric utility applications. A. R. Landgrebe, J. W. Mayo, S. Ruby (U.S. Department of Energy, Washington, D.C.), R. C. Chudacek, and I. B. Weinstock (Aerospace Corp., Germantown, Md.). In: Energy to the 21st\_century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1178-1186, 23 refs.

A80-48326 # Low maintenance lead-acid batteries for energy storage. B. W. Burrows, W. G. Sunu (Gould, Inc., Rolling Meadows, Ill.), and B. H. Dick (Gould, Inc., Industrial Battery Div., Langhorne, Pa.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1187-1191. 6 refs.

Low-maintenance lead-acid batteries suitable for both deep- and shallow-cycle applications have been developed in order to decrease

#### **07 ENERGY STORAGE**

maintenance costs and increase reliability. The low-maintenance characteristic is achieved by the use of a positive grid alloy that contains only 1.5% Sb coupled with an Sb-free negative grid alloy. This hybrid grid alloy combination has all the advantages of an Sb-free combination and none of the disadvantages. In tests with 400 Ah cells, it was found that the optimum charge regime for minimum water loss and maximum capacity retention is 5% overcharge at a maximum cell voltage of 2.55 V with a periodic 10% equalization charge.

!A80-48327 # An advanced technology iron-nickel battery for electric vehicle propulsion. W. Feduska and R. Rosey (Westinghouse Research and Development Center, Pittsburgh, Pa.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. Institute of Aeronautics and Astronautics, Inc., 1980, p. 1192-1197. 7 refs. U.S. Department of Energy Contract No. 31-109-38-4141.

The paper reviews the present status of a DOE-sponsored program involving the improvement of iron-nickel battery technology and the reduction of its cost in accordance with prescribed DOE/ANL goals. These goals are: 60 Wh/kg, 135 Wh/l, 175 W/kg, 60% energy efficiency at the C/3 rate, \$60/KWh selling price (1977 dollars), and a long cycle life capability in a battery of about 25 kWh. An advanced iron-nickel cell, module, and battery have been designed and the first battery has been constructed which shows improved performance over past technology in meeting the projected program goals for 1980, based on plate, cell, module, and initial prototype battery test results.

A80-48328 # Nickel hydrogen battery for load leveling application. V. J. Puglisi, A. S. Berchielli, and C. P. Donnel (Whittaker Corp., Yardney Electric Div., Pawcatuck, Conn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1198-1202. 15 refs. Research supported by the Whittaker Corp.

A80-48329 \* # Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells. J. J. Smithrick (NASA, Lewis Research Center, Cleveland, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1203-1206. 7 refs. Contract No. FC-77-A-31-1044

Five amp-hour nickel-zinc cells were life cycled to evaluate four different charge methods. Three of the four waveforms investigated were 120 Hz full wave rectified sinusoidal (FWRS), 120 Hz silicon controlled rectified (SCR), and 1 kHz square wave (SW). The fourth, a constant current method, was used as a baseline of comparison. Three sealed Ni-Zn cells connected in series were cycled. Each series string was charged at an average c/20 rate, and discharged at a c/2.5 rate to a 75% rated depth. Results indicate that the relatively inexpensive 120 Hz FWRS charger appears feasible for charging 5 amp-hour nickel-zinc cells with no significant loss in average cycle life when compared to constant current charging. The 1-kHz SW charger could also be used with no significant loss in average cycle life, and suggests the possibility of utilizing the existing electric vehicle chopper controller circuitry for an on-board charger. There was an apparent difference using the 120 Hz SCR charger compared to the others, however, this difference could be due to an inadvertent severe overcharge, which occurred prior to cell failure. The remaining two positive pulse charging waveforms, FWRS and 1 kHz, did not improve the cycle life of 5 amp-hour nickel-zinc cells over that of constant current charging. (Author)

A80-48330 # Temperature limitations of alkaline battery electrodes. M. C. H. McKubre (SRI International, Menlo Park, Calif.) and D. D. Macdonald (SRI International, Menlo Park, Calif.; Ohio State University, Columbus, Ohio). In: Energy to the 21st century;

Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1207-1214. 37 refs. Contract No. EM-78-C-01-5159.

The present study investigates possible temperature limitations in Ni-Fe and Ni-Zn aqueous alkaline battery systems which are induced by kinetic or thermodynamic effects in the temperature range -20 to 120 C. The principal temperature limitation of Ni appears to be reduced Coulombic efficiency at high temperature as a result of the coevolution of oxygen at a high state of charge. The irreversible component of charging also increases immediately following the prolonged discharge of Ni. The temperature limitations of the negative electrode materials, Fe and Zn, are more serious and complex than those of Ni.

A80-48334 # Experimental and theoretical studies of thermal energy storage in aquifers. C. F. Tsang (California, University, Berkeley, Calif.), F. J. Molz, and A. D. Parr (Auburn University, Auburn, Ala.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1244-1248. 12 refs. Research sponsored by the U.S. Department of Energy.

A coupled experimental and theoretical study of thermal energy storage in an aquifer is described. Water at an average temperature of 55 C is stored in a confined aquifer near Mobile, Alabama. Approximately 55,000 cu m of water was injected, stored, and then produced for two consecutive cycles. Data obtained were used to validate a numerical model, 'CCC'. This model is able to calculate heat and fluid flow in a three-dimensional, liquid-saturated system. Without adjusting any parameters, the calculated results reproduce closely the observed data. The energy recovery factor of 66% for the first cycle and 76% for the second cycle indicate that the aquifer may be a very promising thermal energy storage medium. Furthermore, the thermohydrological processes involved appear to be properly accounted for by the numerical model, thus giving some confidence in the current state-of-the-art in the performance forecast of future aquifer energy storage projects. (Author)

A80-48335 # Seasonal thermal energy storage of chilled water in aquifers. S. G. Angus and G. T. Williams (Hooper and Angus Associated, Ltd., Toronto, Canada). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics

and Astronautics, Inc., 1980; p. 1249-1254.

The use of aquifers for purposes of offsetting building air-conditioning loads appears to produce considerable economies in locales where suitable aquifers are available. The technical, economic, and environmental feasibility of providing air-conditioning using aquifer thermal energy storage (ATES) is assessed. System cooling sizes are examined with peak capacities ranging from 1250 to 1,250,000 MJ/hr (100 to 100,000 tons). Four aquifer based cooling options are compared: water mining, cold mining, ATES for air-conditioning, and ATES for air-conditioning and heating. The conditions under which these options prove superior to conventional mechanical refrigeration techniques are presented. (Author)

A80-48336 # Temperature-induced permeability alterations in unconsolidated and consolidated aquifer media. J. A. Stottlemyre (Battelle Pacific Northwest Laboratories, Richland, Wash.) and C. H. Cooley (Terra Tek, Inc., Salt Lake City, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1255-1258. 8 refs.

The technical and economic feasibility of Seasonal Thermal Energy Storage (STES) depends, in part, on the long-term structural and chemical stability of subsurface reservoirs exposed to incre-

mental temperatures and stresses. Permeability of sands and sandstones to liquid water has been reported to significantly decrease over the temperature range of interest to STES (4 to 160 C). Similar changes are not observed for dry gases, mineral oil or octanol. This paper is a discussion of some potential causes of this phenomenon: (1) differential thermal expansion, (2) hydrolytic (chemical) weakening leading to densification and/or particulate plugging of the porous material, and (3) dissolution and/or suspension of silica leading to a higher viscosity than measured for distilled water at a given temperature. An experimental program is described to investigate the temperature sensitivity of the permeability to liquid water in natural aquifer materials. (Author)

The economics of aquifer storage of chilled water for air conditioning. R. W. Reilly, D. R. Brown, and H. D. Huber (Battelle Pacific Northwest Laboratories, Richland, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. : New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1265-1271. Research supported by the U.S. Department of Energy.

The cost of supplying chill energy to a point demand using winter chill stored in aquifers is investigated. A simulation code, AQUASTOR, is employed to evaluate the effect of a number of technical and economic parameters on the cost of cooling. These include: system size, load factor, transmission distance, load reject temperature, source availability, source temperature, aquifer thermal efficiency, well cost, electricity cost, and interest rate. The cost of Aquifer Thermal Energy Storage (ATES) cooling is found to be highly dependent upon site-specific conditions. Under a number of conditions ATES cooling is found to be cost competitive with both (Author) electric compression devices and absorption chillers.

A80-48338 # Development of a compressed air energy storage power generation plant - The PEPCO demonstration plant study. E. D. Shippey (Acres American, Inc., Columbia, Md.) and P. E. Schaub (Potomac Electric Power Co., Washington, D.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, New York, American Institute 1980. Volume 2. of Aeronautics and Astronautics, Inc., 1980, p. 1272-1276. Research supported by the Electric Power Research Institute, Potomac Electric Power Institute, and the U.S. Department of Energy.

The paper discusses the results of a two and one-half year study. to develop a compressed air energy storage power plant for the Potomac Electric power system. The plant is based on a split Brayton cycle with a hard rock-mined cavern used for storage of the high pressure compressed air. The concept provides an economically feasible system for allowing a utility to meet its peak load requirements and reduce its consumption of premium fuels. (Author)

A80-48339 # The economics of compressed air energy storage with thermal energy storage, R. W. Reilly (Pacific Northwest Laboratories, Richland, Wash.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1277-1283, 5 refs, Research supported by the U.S. Department of Energy.

The cost of power generated by compressed air energy storage (CAES) with thermal energy storage is compared against the cost of power from conventional fuel-fired CAES and conventional combustion turbines. Two cases are investigated: low compression energy cost (11.4 mills/kWh) and high compression energy cost (25 mills/kWh) at four capacity factors (5%, 10%, 20%, and 30%). The results of the study indicate that the CAES designs enjoy a cost advantage over the fuel-intensive conventional modes of peak and intermediate power generation under almost all conditions investigated. (Author)

A80-48368 # Sandia battery program for energy storage in photovoltaic systems. D. L. Caskey, R. P. Clark, and A. E. Verardo (Sandia Laboratories, Albuquerque, N. Mex.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. New York, American Institute of Volume 2. Aeronautics and Astronautics, Inc., 1980, p. 1459-1464. Research supported by the U.S. Department of Energy.

A80-48369 # Development of a bipolar Zn/Br2 battery. R. J. Bellows, H. Einstein, P. Grimes, E. Kantner, K. Newby, and J. A. Shropshire (Exxon Advanced Energy Systems Laboratory, Linden, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1465-1470. 10 refs.

Development of an advanced battery system based on the Zn/Br2 couple has emphasized a low cost approach utilizing conductive plastic electrodes, circulating electrolytes and bromine complexation. Bipolar stack designs are attractively cost-effective but can be troubled by shunt currents in the electrolyte manifolds. A novel technique has been developed to control shunt current problems. This technique, called shunt current protection, passes auxiliary current in the common electrolyte manifolds. Present testing of this technology on a 52-cell bipolar stack with 600 sq cm electrodes shows typical discharges of 80 V and peak power pulses approaching 14 watt/sq dm. Performance has remained stable at 85-90% coulombic efficiency. The technology is adaptable to both electric vehicles and energy storage usage, 20 kWh designs of present technology show 62-66 Wh/kg and 85 Wh/I and are estimated to OEM at \$40/kWh (\$ 1979) in assembly line production.

A80-48370 \* # Improvement and scale-up of the NASA Redox storage system, M. A. Reid and L. H. Thaller (NASA, Lewis Research Center, Cleveland, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 1471-1476. 9 refs.

A preprototype full-function 1.0 kW Redox system (2 kW peak) with 11 kW storage capacity has been built and integrated with the NASA/DOE photovoltaic test facility. The system includes four substacks of 39 cells each (1/3 sq ft active area) which are connected hydraulically in parallel and electrically in series. An open circuit voltage cell and a set of rebalance cells are used to continuously monitor the system state of charge and automatically maintain the anode and cathode reactants electrochemically in balance. Technological advances in membrane and electrodes and results of multicell stack tests are reviewed. V.L.

A80-48371 # Performance and structural characteristics of the iron-air battery system. B. G. Demczyk, W. A. Bryant, C. T. Liu, and E. S. Buzzelli (Westinghouse Research and Development Center, Pittsburgh, Pa.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc.,

1980, p. 1477-1479. 5 refs. Research supported by the U.S.

Department of Energy.

The iron-air battery system, which couples a porous, sintered iron electrode to a carbon-based bifunctional air electrode, possesses the near-term capability for electric vehicle propulsion at an energy density of 110 Wh/kg and power delivery of greater than 100 W/kg. The battery will have an expected life in excess of 1000 full charge-discharge cyclestand will be available at a manufacturing cost of less than \$40/kWh. Based on the current half-cell performances of the individual electrodes, it is fully expected that these system performance goals will be realized in the foreseeable future. (Author)

#### 07 ENERGY STORAGE

A80-48372 # Development of a lithium-water-air primary battery. W. R. Momyer and E. L. Littauer (Lockheed Research Laboratories, Palo Alto, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1480-1486.

The lithium-water-air (Li-H2O-air) battery is one of the reactive metal-air systems being considered for automotive propulsion. Li-H2O-air cells with active electrode areas of 500 sq cm have been discharged in a modular cell apparatus casing to access the scale up features of the system. 6-cell-1 kW Li-H2O-air batteries were successfully discharged at the design level (0.4 W/sq cm) over periods of several hours. No significant scaling factor was found in either the electrode area or in the number of cells. (Author)

A80-48373 # The aluminum-air battery for electric vehicle propulsion. J. F. Cooper, R. V. Homsy, and J. H. Landrum (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1487-1495. 21 refs. Research supported by the Continental Group, Inc.; Contract No. W-7405-eng-48.

This report reviews the status of aluminum-air battery development and discusses the use of aluminum as a recyclable electrochemical fuel. The battery combines high specific energy (above 300 Wh/kg) and specific power (150-200 W/kg) with the capability of rapid refueling by addition of reactants. The objective is a commercially-feasible, general-purpose electric vehicle. Progress is reported in the scale-up of aluminum-air single cells to the automotive scale (0.1 sq m-anodes) and in the development of a hydrargillite crystallizer, which is required to control electrolyte composition. Major technical problems and development strategy are discussed. The total cost and energy required to produce aluminum, and projected consumption by electric vehicles indicates that the aluminum-air powered electric vehicle is potentially competitive with advanced automobiles using synthetic liquid fuels. (Author)

A80-48374 # The new age of high performance kinetic energy storage systems. D. Davis and A. Csomor (Rockwell International Corp., Rocketdyne Div., Canoga Park, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1507-1512. 13 refs.

The concept of flywheel energy storage is discussed with reference to several programs now underway. One of them involves a steel rotor system with a total energy storage capacity of 30 kW-hr which includes four individual flywheel disks of which two are mounted on counter-rotating shafts interconnected through a gearbox. Another program deals with composite flywheels which, because of their higher strength-to-weight ratios, offer the potential of maximum energy densities of 35 W-hr/lb. A third program deals with the application of a flywheel energy storage system in a shuttle car for transporting coal in coal mines. The system will power a shuttle car of at least 20 tons gross weight for a distance of 550 feet up a 3% grade (plus 550 feet unloaded), with a rolling resistance of at least 200 lb/ton.

A80-48375 # Performance and applications potential of a turbine-pump with controlled flow rate. G. C. Chang (Cleveland State University, Cleveland, Ohio), A. Gokhman, and N. Ozboya (EDS Nuclear, Inc., San Francisco, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1513-1521. 7 refs.

Design, hydraulic, and application potential analyses are presented for a turbine-pump with controlled flow rate (TPCFR) in

which the flow rate is regulated by means of change of the water passage height in both turbine and pump modes. In order to change the height of the water passage, TPCFR has an additional adjustable hub in the runner and movable upper cover in the wicket gate; both these additional parts can move along the axis of the machine. Operating as a turbine, this machine delivers a peak efficiency of 90%. In the pump mode, the overall efficiency at 50% partial load is 90%; it tapers off slowly to 85% at peak design load. The ability of TPCFR to regulate flow rate in the pump mode makes it attractive for pumped storage plants and storage of energy generated by solar and wind-electrical plants.

A80-48376 # Coal-fired fluid bed combustion augmented compressed air energy storage systems. A. J. Giramonti, R. D. Lessard (United Technologies Research Center, East Hartford, Conn.), and D. Merrick (Coal Processing Consultants, Ltd., Harrow, Middx., England). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc.,

1980. p. 1522-1527.

Compressed Air Energy Storage (CAES) systems are being aggressively studied for U.S. electric utility load leveling applications. The CAES concept consists of compressing air during off-peak periods, storing it underground, and withdrawing it during peak load periods for expansion through gas turbines to generate power. All contemplated first generation CAES power plants would consume premium petroleum fuel during the power generation mode. This paper presents highlights of a study program to assess the technical and economic feasibility of completely eliminating the consumption of petroleum by the use of coal-fired, Pressurized Fluid Bed Combustors (PFBC) in second generation CAES plants. The results of the study indicate that commercial application of PFBC/CAES power plants during the late 1980's or early 1990's appears feasible, depending on how aggressively this technology is pursued. PFBC/ CAES power plants should be economically competitive with conventional oil-fired power plants for annual utilization above about 1600 hours per year. (Author)

A80-48377 # Residential photovoltaic flywheel storage system performance and cost. R. D. Hay, A. R. Millner, and P. O. Jarvinen (MIT, Lexington, Mass.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics

and Astronautics, Inc., 1980, p. 1528-1533. 6 refs. Research sponsored by the U.S. Department of Energy.

A subscale prototype of a flywheel energy storage and conversion system for use with photovoltaic power systems of residential and intermediate load-center size has been designed, built and tested by MIT Lincoln Laboratory. System design, including details of such key components as magnetic bearings, motor generator, and power-conditioning electronics, are described. Performance results of prototype testing are given and indicate that this system is the equal of or superior to battery and inverter systems for the same application. Results of cost and user-worth analysis show that residential systems are economically feasible in stand-alone and in utility-interactive applications. (Author)

A80-48378 # Flywheel-transmission characteristics required for break-even impact on automotive vehicle performance. R. F. McAlevy, III (Stevens Institute of Technology, Hoboken, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York; American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1534-1538. 6 refs.

Flywheel-transmission characteristics that are just sufficient to produce no change in (i.e., 'break-even') vehicle (1) mass and (2) energy economy are derived from simple algebraic equations for

vehicle: (1) energy balance, (2) power balance and (3) total mass equal to the sum of component masses. Depending on a combination of vehicle energy-storage device and mission parameters, the boundary between vehicle power-determined and range-determined design regimes is established. In each, the flywheel-transmission characteristics required for break-even mass were found to be more stringent than those for break-even energy economy. But due to the possibility of substituting flywheel-transmission mass for storage-device mass in vehicles of power-determined design, flywheel-transmissions of greater mass can be tolerated and still result in break-even performance levels. (Author)

A80-48394 # RCA Satcom F1 and F2 Ni-Cd battery orbital performance. S. J. Gaston (RCA, Astro Electronics Div., Princeton, N.J.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1623-1626.

It is shown that the Ni-Cd batteries aboard the F1 and F2 spacecraft have performed exceptionally well, and that the voltage degradation, as measured at the end of the maximum eclipse duration, was lower than predicted. These flight data are compared to published data for Intelsat IV (flights 2, 3, and 4) and published data from Crane tests. The Satcom battery performance is consistent with the Crane data and superior to the battery performance on the Intelsat spacecraft. The superior performance of the Satcom batteries attributed to the use of teflonated negative electrodes, increased electrolyte quantity, applications of individual cell draining resistors prior to each eclipse season for reconditioning, the use of continuous trickle charge during the noneclipse seasons, and provision for low temperature operation.

A80-48395 # The Intelsat V nickel- cadmium battery system. J. D. Armantrout, T. O. Meyer, and D. C. Briggs (Ford Aerospace and Communications Corp., Western Development Laboratories Div., Palo Alto, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1627-1631. Research sponsored by the International Telecommunications Satellite Organization.

The Intelsat V battery energy storage system consists of two 28-cell 34 Ah nickel-cadmium batteries designed to yield a minimum of 7 years of orbital operation at 55% depth of discharge (DOD). Accelerated life-cycle tests performed at 55% DOD on a qualification test battery have demonstrated a 10-year synchronous orbit cycle capability. Additionally, two other qualification battery life tests are being conducted; one that simulates orbital operation in real time and another that simulates eclipse seasons in real time with accelerated solstice periods. Preliminary results from 1-1/2-years of real-time and 4 years of semiaccelerated testing show correlation with accelerated test results. To date, one engineering model, three qualification units, three integration test, and eight flight battery assemblies have been successfully built and tested. (Author)

A80-48396 # Aerospace nickel-cadmium/nickel-hydrogen electrode process facility. L. E. Miller (Eagle-Picher Industries, Inc., Joplin, Mo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1632, 1633.

A unique low volume, high quality, nickel and cadmium electrode process facility has been established for the production of aerospace system electrodes (Ni-Cd, Ni-H2, etc.). The facility capability includes both vacuum and electrochemical impregnated electrodes of the sintered nickel type. Facility design features process olution isolation, completely inert material construction and small, individual segment material process control assuring a low contamination, very uniform product. (Author)

A80-48397 # Application of battery reconditioning techniques to achieve capacity restoration - A case history. C. Lurie (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1634-1637. 5 refs.

Reconditioning has traditionally been used as a means of maintaining the performance of normal cells and batteries. This paper describes a situation in which reconditioning was used to improve the performance of nickel-cadmium batteries believed to contain partially shorted cells. The approach discussed has been used successfully on operational satellites. The satellite mission and power subsystem are briefly described. On-orbit anomaly analyses and subsequent ground tests led to the conclusion that cells in the batteries were experiencing shorting events. In-flight reconditioning procedures were adjusted to accommodate the batteries containing the damaged cells. The observation that reconditioning temporarily diminished or eliminated shorted-cell behavior led to the use of multiple reconditionings. A mechanism is proposed wherein reconditioning causes remission of the undesirable partially-shorted-cell characteristics. (Author)

A80-48398 \* # Nickel-cadmium batteries for the Modular Power Subsystem. V. C. Mueller and D. A. Webb (McDonnell Douglas Astronautics Co., St. Louis, Mo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1638-1642. NASA-supported research.

Nickel-cadmium batteries of 20 and 50 ampere-hour (AH) capacity have been developed and qualified. These batteries provide an energy storage capability of 40 to 150 AH for the Modular Power Subsystem, which is the power source for NASA's Multimission Modular Spacecraft. Battery fabrication is rigidly controlled to assure uniform performance from battery to battery. A unique feature of the battery design is that cells from various manufacturers can be used for battery assembly without modification. Both 20 and 50-AH batteries have been delivered, and an MPS module with three 20-AH batteries is currently operating satisfactorily in low earth orbit. Design characteristics and performance of the batteries are described. (Author)

A80-48399 # Performance of the recently developed Ni-Cd cells for the ETS-III batteries. M. Shimodaira (National Space Development Agency of Japan, Tokyo, Japan), T. Shirogami, K. Murata (Toshiba Corp., Energy Science and Technology Laboratory, Kawasaki, Japan), and K. Takagi (Toshiba Corp., Kawasaki, Japan). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1643-1646. 5 refs.

Prismatic 8Ah Ni-Cd cells for the Japanese ETS III satellite were examined by accelerated thermal cycling life tests at 30 C and found to perform well for several thousand cycles on the condition that the charge/discharge Ah ratio was 1.08 + or - 0.01. In addition, the reconditioning of discharging to 1.00 V/cell is found to be effective for the recovery of the performance of degraded cells. Reconditioned cells are capable of performing well for approximately another thousand cycles.

B.J.

A80-48400 # Linear constraints aid selection of battery charge control parameters. N. B. North (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of

Aeronautics and Astronautics, Inc., 1980, p. 1647-1652. Contract No. F04701-74-C-0450.

This paper presents an objective and quantitative method for simplifying the determination of design parameters of a battery charge controller for an orbiting spacecraft. Charge current requirements can be defined quantitatively for spacecraft batteries to place upper and lower limits on battery charge current and on battery temperature during particular modes of operation. These requirements are established to: (1) ensure adequate recharge following discharge periods. (2) preclude excessive overcharge and attendant physical stress within the battery cells, and (3) help maintain suitable operating temperatures for batteries by controlling internal dissipation. Each charge current requirement for a representative geosynchronous orbit application is transformed to an equivalent requirement stated in terms of component values and operating voltage for the charge controller. All such charge controller requirements are presented as linear inequalities which collectively define feasible combinations of component values and voltage levels (the nonlinearity of battery charge and overcharge characteristics does not preclude the use of these linear relationships). This definition of a feasible operating region indicates the potential existence of a realizable charge controller design; alternatively, if no feasible region exists, then over-specification of battery charge requirements may have occurred. Once feasibility is established and defined, the selection of charge controller parameters becomes greatly simplified. (Author)

A80-48401 \* # An accelerated test design for use with synchronous orbit. P. P. McDermott and K. L. Vasanth (Coppin State College, Baltimore, Md.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 2. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1653-1657. 13 refs. Grant No. NsG-5051.

The Naval Weapons Support Center at Crane, Indiana has conducted a large scale accelerated test of 6.0 Ah Ni-Cd cells. Data from the Crane test have been used to develop an equation for the description of Ni-Cd cell behavior in geosynchronous orbit. This equation relates the anticipated time to failure for a cell in synchronous orbit to temperature and overcharge rate sustained by the cell during the light period. A test design is suggested which uses this equation for setting test parameters for future accelerated testing.

A80-48437 # Status of COMSAT/INTELSAT nickel-hydrogen battery technology. J. D. Dunlop and J. F. Stockel (COMSAT Laboratories, Clarksburg, Md.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1878-1884. Research sponsored by the International Telecommunications Satellite Organization.

This paper presents the status of the COMSAT/INTELSAT nickel-hydrogen (Ni-H2) battery technology, which evolved from a cell design with an 8.89-cm (3.5-in.) diameter and with the length varied to meet different ampere-hour requirements. Battery technology is described in terms of energy density, energy per unit volume, structural designs, and heat transfer data. These variables are compared for NTS-2, INTELSAT V flight batteries, and two advanced batteries. The maximum energy density achieved is 60.1 Wh/kg for the high-pressure 50-Ah cell. (Author)

A80-48438 # Nickel-hydrogen batteries for INTELSAT V. G. van Ommering, C. W. Koehler, and D. C. Briggs (Ford Aerospace and Communications Corp., Western Development Laboratories, Palo Alto, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc.,

1980, p. 1885-1890. 11 refs. Research sponsored by the International Telecommunications Satellite Organization.

The first nickel-hydrogen battery for a long-life synchronous satellite application is intended for possible incorporation into the later spacecraft in the INTELSAT V series. This new energy storage system promises to extend spacecraft life expectancy while providing other benefits, including mass reduction and battery state-of-charge telemetry. The characteristics and design of the INTELSAT V nickle-hydrogen battery are compared with those of the nickel-cadmium battery. Improved life and reliability, full compatibility with the spacecraft and interchangeability of the two battery systems are major design requirements. The background of the nickel-hydrogen technology is discussed, and a projection is made of the capabilities of future batteries using optimized cell designs. (Author)

A80-48439 # Nickel hydrogen battery advanced development program status report. E. Adler, S. Stadnick, and H. Rogers (Hughes Aircraft Co., El Segundo, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1891-1896. 5 refs. USAF-supported research.

The development of nickel hydrogen battery technology for spacecraft use involve the design, fabrication, and testing of HiH2 cells and related hardware. The cell design addressed critical areas related to pressure vessel design, electrolyte management, oxygen management, and thermal management while operating in typical low earth and geosynchronous earth orbital environments. Several of the cells tested at Hughes have successfully completed a series of environmental tests and have logged in excess of 6500 cycles in 60 percent depth of discharge low earth orbit operation and 5500 cycles in 80 percent low earth orbit operation. Research to evaluate self-discharge, rapid oxygen recombination, negative electrode flooding, and fracture mechanics characteristics of Inconel 718 are being pursued. This effort resulted in the incorporation of knit Zircar (zirconium oxide cloth) separators into the cell design and the identification of a negative electrode treatment that enhances the hydrophobic behavior of negative electrodes. (Author)

A80-48440 # Nickel hydrogen battery for a spacecraft power subsystem. S. J. Stadnick (Hughes Aircraft Co., El Segundo, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1897-1900.

The paper reports on a nickel-hydrogen battery which provides longer shelf and mission life, lighter weight, and more reliability than conventional nickel-cadmium batteries for spacecraft. The power subsystem which is similar to the NiCd battery is described, including the cylindrical solar array, battery discharge controllers, and current sensors; the baseline battery complement for the spacecraft consisting of two 25 A-ht NiH2 batteries is discussed along with platinum catalyst electrode cells and Zircar (yttrium stabilized zirconium oxide) cloth separators. Tests demonstrated that the temperature differential between the cell stack and the pressure vessel is less than 3 F, and the large surface area of the cell/thermal collar interface allows complete electrical insulation and provides a good thermal path.

A.T.

A80-48441 \* # Nickel-hydrogen battery integration study for the Multimission Modular Spacecraft. V. C. Mueller (McDonnell Douglas Astronautics Co., St. Louis, Mo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1901-1907. 5 refs. NASA-supported research.

A study has been performed to determine the feasibility of using nickel-hydrogen batteries as replacements for the nickel-cadmium batteries currently used for energy storage in the Multimission Modular Spacecraft under a contract with NASA Goddard Space Flight Center. The battery configuration was selected such that it meets volumetric and mounting constraints of the existing battery location, interfaces electrically with existing power conditioning and distribution equipment, and maintains acceptable cell operating temperatures. The battery contains 21, 50 ampere-hour cells in a cast aluminum structural frame. Cells used in the battery design are those developed under the Air Force's Aero Propulsion Laboratory funding and direction. Modifications of the thermal control system were necessary to increase the average output power capability of the Modular Power Subsystem. (Author)

A80-48443 # Life cycle test of Air Force nickel-hydrogen flight experiment battery. M. G. Gandel (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1912-1914.

Life cycle testing of a full-scale, flight qualified, 21-cell 50 Ah Nickel Hydrogen battery was undertaken to demonstrate the flight-readiness of this system for high depth-of-discharge, Low Earth Orbit (LEO) satellite application. The battery under test is a duplicate of the unit flown by the Air Force in a flight experiment in 1977. Between June 1978 and October 1979, the unit has been charge/discharge cycled over 6000 simulated LEOs to 51 percent depth-of-discharge. Heat rejection through the base plate results in high thermal gradients which require limiting overcharge; however, capacity has been maintained by recharge ratios of 1.03 to 1.13. Voltage, pressure, and thermal characteristics as a function of charge control mode, state-of-charge, base plate temperature, and cycle life are presented. Electrolyte maldistribution effects have been observed and corrected by rotation of the battery. (Author)

A80-48444 # Cycling characteristics of nickel-hydrogen cells. P. F. Ritterman (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1915-1917. 6 refs.

Cycling and postcycling teardown analysis data are presented for nickel-hydrogen cells at various stages of development; the data pertain to cells from engineering models of 1972 to 1974 to the present-day low-volume high-pressure flight-quality cells. The most notable improvement affecting the life and performance of nickel-hydrogen cells in geosynchronous orbit cycling can be attributed to the replacement of vacuum-impregnated positive electrodes by electrochemically impregnated positive electrodes.

B.J.

A80-48445 # Establishment of parameters for production of long life nickel oxide electrodes for nickel-hydrogen cells. D. F. Pickett, H. H. Rogers, L. A. Tinker (Hughes Aircraft Co., Technology Div., El Segundo, Calif.), C. A. Bleser, J. M. Hill, and J. S. Meador (Eagle-Picher Industries, Colorado Springs, Colo.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 1918-1924. 10 refs.

This program was undertaken to define process parameters necessary for quantity production of aerospace nickel oxide electrodes with sufficient production controls to ensure a quality product. To achieve this objective, a comprehensive study was carried out to optimize a process, proven at the laboratory level, for flight production. Variables included in the study were: gravity versus slurry sintering process, sinter strength, substrate cleaning technique, age of impregnating solution, rinse technique, and method of current distribution. Electrodes produced in the course of the

study were evaluated using a 10C-rate charge/discharge, 200 cycle, stress test including 100 percent overcharge. The effect of variables on electrodes produced was judged by the following criteria: blistering, swelling, capacity loss, and loss of active material.

(Author)

A80-48446 # Test data analysis and application of nickel hydrogen cells. L. W. Barnett, B. M. Otzinger, and E. Paulsen (Rockwell International Corp., Power Equipment Group, Seal Beach, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980. p. 1925-1928.

This paper deals with testing nickel-hydrogen cells. The test articles were four single-pressure-vessel (SPV) and two commonpressure-vessel (CPV) devices. Charge-discharge efficiency tests from -20 C to +20 C were conducted. It was determined that the SPV Hughes cell experienced significant capacity growth after 30 cycles and that final capacity is a function of rate of charge. An attempt to determine the delta temperature between CPV cells that prohibited electrolyte transfer between cells was not successful because of cell construction. Charge retention tests on a CPV device indicated the same rate of self-discharge as the single-pressure-vessel device. Thermal test and analysis results show a 16.1-percent loss of energy to heat in the charge mode. Tests also show a result of 16.7-percent loss of energy to heat in the discharge mode. The 16.7-percent discharge data are questionable. A significant parameter noted in single-pressure-vessel testing was that higher capacities resulted in tests at lower temperatures down to -20 C.

A80-48471 # An analysis of aluminum-air battery propulsion systems for passenger vehicles. J. D. Salisbury and E. Behrin (California, University, Livermore, Calif.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2080-2088. 17 refs. Contract No. W-7405-eng-48.

The performance characteristics of three electric-propulsion systems based on the Al-air battery were analyzed and compared to the internal combustion engine (ICE). In this comparison, the engine and fuel systems of a current five-passenger vehicle were conceptually replaced by three Al-air systems: (1) an Al-air battery-only system, (2) an Al-air battery combined with a nickel-zinc secondary battery for power leveling, and (3) an Al-air battery combined with a flywheel power leveler. Performance characteristics such as the average consumption rate of Al metal for the selected drive cycle. vehicle mass, and power system mass were determined for each Al-air propulsion system. Estimates of initial-vehicle and life-cycle costs of Al-air battery-only vehicles indicate that all three systems can achieve performance and operation costs comparable to an ICE vehicle, and that the initial cost of Al-air battery-only vehicles can approach the cost of ICE vehicles but at reduced power levels. (Author)

A80-48478 # Simulation and evaluation of latent heat thermal energy storage heat pump systems. T. W. Sigmon, J. H. Davidson, J. M. Doster (Research Triangle Institute, Durham, N.C.), J. F. Martin (Oak Ridge National Laboratory, Oak Ridge, Tenn.), and J. A. Edwards (North Carolina State University, Raleigh, N.C.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2117-2122. 5 refs. Contract No. DE-AC01-79ET-26707.

A computer program has been developed for the purpose of determining the performance characteristics of a number of latent heat thermal energy storage (TES)/heat pump system configurations that provide for space heating and cooling. The basis of the simulation program is the determination of equilibrium values for

## **07 ENERGY STORATE**

heat transfer and refrigerant mass flow within the refrigeration cycle of any TES/heat pump system during the various possible modes of operation. These equilibrium values have been found using manufacturer's performance data for the conventional heat pump components comprising such a system, while a detailed mathematical model has been developed for a specific latent heat TES subsystem design. The purpose of this paper is to present the technical approach followed and the results that have been obtained for a specific TES/heat pump configuration that can be used for storage heating. Results for the particular case considered here suggest that the thermal efficiency of the heat pump can be improved substantially when combined with a latent heat TES subsystem. (Author)

A80-48483 # Nickel-zinc batteries for aircraft and aerospace applications. R. A. Brown (Eagle-Picher Industries, Joplin, Mo.) and J. S. Cloyd (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2144-2148. USAF-supported research.

Interim results are presented for a U.S. Air Force sponsored program dealing with the development and testing of nickel-zinc batteries for certain aircraft and aerospace applications. Military battery applications that require the best over-all combination of long calendar and cycle life, low weight, low volume, high performance, and low life cycle costs are prime applications for nickel-zinc batteries. Basic characteristics, shortcomings and unique features of the nickel-zinc system are discussed. Development of Remotely Piloted Vehicle (RPV) type aircraft batteries is discussed, including separator testing and nickel electrode comparisons. Design data and battery test results are presented for nickel-zinc aircraft batteries designed for two specific RPV applications. Also presented is design data and test results for large capacity nickel-zinc cells for stand-by power sources.

(Author)

A80-48484 # New separator materials for nickel-cadmium aircraft batteries. J. J. Lander (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3. New York, American Institute of Aeronautics and Astronautics, Inc., 1980, p. 2149-2152. 13 refs.

During the past two decades there has been much activity in the development of new separator materials for replacement of cellophane in alkaline batteries. The Air Force sponsored development of Permion 2291 which proved on laboratory life tests in aircraft batteries to outlast cellophane by 3-10 times. In late 1976, the Air Force began a program to convert all its nickel-cadmium aircraft batteries to use of Permion on an attrition basis. Performance to date has been satisfactory and cost savings in replacement cells is accruing. Another material, Celgard 3400 has life equivalent to Permion and better cold temperature performance. Both materials are acceptable for use under the new Tri-Service Ni-Cd Aircraft Battery Specification. (Author)

A80-48489 # Hybrid lithium/nickel-zinc large missile ground power source. E. W. McDonald (Honeywell Power Sources Center, Horsham, Pa.), M. G. Klein, and A. J. Leo (Energy Research Corp. Danbury, Conn.). In: Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volume 3.

New York, American Institute of Aeronautics and Astronautics, Inc.,

New York, American Institute of Aeronautics and Astronautics, Inc 1980, p. 2176-2181. Contract No. F04704-77-C-0014.

Honeywell conducted advanced development of a survivable ground power source for a large missile system. The requirements and goals of this system in terms of energy density and attendant cell performance has resulted in the development of large lithium-thionyl chloride (Li/SOCI2) cells providing the emergency post attack

capability and large nickel-zinc (Ni/Zn) cells providing the secondary standby capability for pre-attack commercial power outages. To select the proper Li/SOCI2 cell designs, experimental investigations were conducted with cell sizes ranging from 17 to 500 Ah. Final scale-up was successfully demonstrated in 17,000 Ah cell sizes. Performance of the Li/SOCI2 cells over the storage and operating environments as well as safety abuse conditions are presented.

(Author)

A80-48766 Lead-acid traction batteries for electric road vehicle propulsion - Directions for research and development. D. A. J. Rand (Commonwealth Scientific and Industrial Research Organization, Div. of Mineral Chemistry, Melbourne, Australia). *Journal of Power Sources*, vol. 5, Sept. 1980, p. 221-234, 105 refs.

Little information exists on the behavior of lead-acid batteries operating under the duty cycles normal to electric road vehicle service. Important battery requirements for the propulsion of traffic-compatible electric vehicles include a deep-discharge capability at high efficiencies of active material utilization, and a long cycle life. In order to optimize power-source characteristics to meet these criteria, especially for passenger cars, it is necessary to gain full knowledge of the influence of actual vehicle service on the performance of traction batteries. This article defines areas in which both fundamental and applied work are required to achieve this aim based on the current performance of the lead-acid system. (Author)

A80-48770 The lithium-sulfuryl chloride battery - Discharge behaviour. G. Razzini, S. Rovellini (CNR, Centro Studio Processi Elettrodici, Milan, Italy), F. Alessandrini, B. Di Pietro, and B. Scrosati (Roma, Università, Rome, Italy). Journal of Power Sources, vol. 5, Sept. 1980, p. 263-271. 14 refs. Research supported by the Consiglio Nazionale delle Ricerche; Grant No. DA-ERO-78-G0039.

The properties of the lithium-sulfuryl chloride battery have been examined in terms of discharge performance and characteristics. The results indicate that the Li/SO2Cl2 system is intrinsically capable of delivering large current outputs at high voltages. Upon storage and long term discharge, however, the cell is affected by the two major polarization phenomena typical of lithium-inorganic electrolyte batteries, i.e., the passivation of the anode and the inactivation of the cathode. (Author)

A80-49718 System design of The Electric Test Vehicle - One /ETV-1/. E. A. Rowland (General Electric Co., Schenectady, N.Y.) and K. W. Schwarze (Chrysler Corp., Highland Park, Mich.). Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800057. 15 p.

The Electric Test Vehicle · One (ETV-1), a four-passenger electric car developed under the sponsorship of the U.S. Department of Energy incorporates improvements in vehicle design, electronics, and battery technology to achieve specified performance, safety, and cost objectives. The present test vehicle would be suitable, with further development, to be mass-produced by the mid-1980's. Performance of the ETV-1 is enhanced by lightweight construction, low aerodynamic drag, and low rolling resistance. Efficiency of the electrical drive subsystem is optimized through the use of a separately excited drive motor with transistorized armature and field controls. An improved lead-acid battery is used to provide high energy and power density. The test vehicles have demonstrated an urban driving range of 119 km, a top speed of 112 km/hr, and a 0 to 48 km/hr acceleration time of less than nine seconds. (Author)

A80-49723 \* Trade-off results and preliminary designs of Near-Term Hybrid Vehicles. J. J. Sandberg (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800064. 17 p. 5 refs.

Phase I of the Near-Term Hybrid Vehicle Program involved the development of preliminary designs of electric/heat engine hybrid passenger vehicles. The preliminary designs were developed on the

basis of mission analysis, performance specification, and design trade-off studies conducted independently by four contractors. The resulting designs involve parallel hybrid (heat engine/electric) propulsion systems with significant variation in component selection, power train layout, and control strategy. Each of the four designs is projected by its developer as having the potential to substitute electrical energy for 40% to 70% of the petroleum fuel consumed annually by its conventional counterpart. (Author)

A80-49726 Impact of electric cars on U.S. petroleum consumption. M. M. Collins and W. M. Carriere (General Research Corp., Santa Barbara, Calif.). Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800108. 10 p. 5 refs.

A computer model that forecasts electricity demand and capacity on an hourly basis for each major electric power company in the United States is used to analyze the potential impact of electric cars on national petroleum consumption in 1980, 1990, and 2000. The analysis, based on 1978 and 1979 growth projections by the industry, shows that if all cars were electrified in the year 2000, autombile petroleum use would be cut by 75 percent, saving 2.5 million barrels of crude oil a day, or 14 percent of future national petroleum consumption. Most cars could be charged overnight from otherwise idle coal and nuclear power plants. (Author)

A80-49729 Analysis of the infrastructure for recharging electric vehicles. R. Kaiser and C. Graver (General Research Corp., McLean, Va.). Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800112. 21 p. U.S. Department of Transportation Contract No. TSC-1693.

The components of an infrastructure required to support a fleet of electric vehicles are analyzed with particular reference to the electric utility companies, the types of dwellings at which it would be practical to recharge electric vehicles overnight, and methods for providing vehicle range extension. Analysis shows that the US utility industry has sufficient capacity to support at least 13 million electric vehicles if they are recharged at night. There are at least 20 million single-family homes where it would be possible to recharge an electric vehicle by adding a branch circuit and a 230 V, 50 A outlet. However, range-extension support is still the missing element of the refuelling infrastructure.

A80-49730 \* Vehicles testing of near-term batteries. R. C. Conover, K. S. Hardy, and J. J. Sandberg (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.). Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800201. 16 p.

Vehicles test results are reported for nickel-iron, nickel-zinc, and improved lead-acid batteries developed under the Near-Term Battery Program sponsored by the Department of Energy. The batteries have demonstrated a range improvement of up to 90% over current lead-acid batteries due to improved energy density and ampere-hour capacity, combined with relatively small weight and volume. However, the nickel-iron battery requires a substantial development effort in packaging the circulating electrolyte system and handling the generated hydrogen volume, while the nickel-zinc batteries tested suffer from short cycle life.

A80-49731 'Biberonnage' makes an electric car practical with existing batteries. H.-G. Mueller (Gesellschaft für elektrischen Strassenverkehr mbH, Essen, West Germany) and V. Wouk (Victor Wouk Associates, New York, N.Y.). Society of Automotive Engineers, Congress and Exposition, Detroit, Mich., Feb. 25-29, 1980, Paper 800204. 13 p. 19 refs.

Tests made with a converted Audi show that a '45 km (27 mi) range' vehicle can be driven over 100 km (60mi) in a day if the batteries are charged when the vehicle is not in use (such charging is called 'biberonnage' by the French). The tests were conducted in an urban area, with the vehicle making frequent short trips, characteristic of urban driving missions. Advantage is taken of the fact that during such driving, the effective speed is only 30 km/h (20 mph).

Graphs are presented for calculating the vehicle range in a given number of operating hours, with different assumed average speeds, and different assumed battery charging rates. It is shown how a range of 160 km (100 mi) per day can be achieved with existing batteries, employing biberonnage. Biberonnage allows the use of a battery pack lighter than normally employed, thus reducing vehicle weight, initial and operating costs, and energy consumption (Wh/km). With biberonnage, electric cars can be introduced in large numbers rapidly. We need not wait for the '100 miles range' battery to make the EV commercially acceptable. (Author)

A80-50508 Evaluation of high temperature LiAI/TiS2 cells. Z. Tomczuk, K. E. Anderson, D. R. Vissers, and M. F. Roche (Argonne National Laboratory, Argonne, III.). Electrochemical Society, Journal, vol. 127, Sept. 1980, p. 1881-1885. 17 refs. Research supported by the U.S. Department of Energy.

The electrochemistry of the TiS2 electrode of Li/TiS2 cells in molten LiCl-KCl was found to be similar to that in room temperature cells. The emf curve for Li(x)TiS2 (x in the range 0-1) was nonlinear and could be treated in terms of a regular solution model. The effect of TiS2 electrode thickness was investigated, and the results indicated that good utilization (70%) could be obtained with thick (0.66 cm) TiS2 electrodes. The performance of engineering-scale LiAl/TiS2 cells (77-142 A-hr capacities) was investigated. (Author)

A80-50910 Community Annual Storage Energy System. W. R. Powell (Johns Hopkins University, Laurel, Md.). Johns Hopkins APL Technical Digest, vol. 1, Apr. June 1980, p. 108-113.

The Community Annual Storage Energy System (CASES) is a new form of heating and cooling that uses buildings instead of expensive devices to collect solar heat, which is then removed during the cooling process in summer, stored, and used as a primary source of heating in winter. CASES also collects the excess heat that is produced in some community buildings even in winter and distributes it to the community to further reduce overall fuel consumption. At times, CASES obtains a portion of the heat required by the community directly from the winter environment.

A80-50911 Energy conservation with flywheels. D. W. Rabenhorst (Johns Hopkins University, Laurel, Md.). Johns Hopkins APL Technical Digest, vol. 1, Apr. June 1980, p. 114-119. 7 refs.

After a summary of flywheel capabilities, the paper reviews energy conservation in vehicular flywheel systems and in stationary flywheel systems. It is shown that the use of flywheels in various transportation applications could significantly reduce fuel consumption and lifetime costs. In addition, the widespread use of flywheels in stationary energy systems could reduce the consumption of fuel in power plants by cutting back on the use of petroleum-consuming equipment that would otherwise be required to accommodate the diurnal peak loads.

B.J.

A80-50945 Heat storage capability of a rolling cylinder using Glauber's salt. C. S. Herrick and K. P. Zarnoch (GE Corporate Research and Development Center, Schenectady, N.Y.). International Journal of Ambient Energy, vol. 1, Jan. 1980, p. 47-55. Research supported by the U.S. Department of Energy.

The thermal properties of a rolling cylindrical phase-change heat storage device using Glauber's salt, sodium sulfate decahydrate, are investigated calorimetrically. Horizontal cylinders made of FERNI-CO alloy and stainless steel were filled with Glauber's salt and rotated about their axes within a calorimeter to measure the heat given off and absorbed by the cylinder during the freezing and melting of the salt at 90.3 F. Results reveal complete phase changes during operation, with a latent heat release up to 100% of theoretical and repeatable performance over 150 melting-freezing cycles. High heat release rates, internal heat transfer rates and heat exchanger surface temperatures are also observed, and freezing is found to occur uniformly. It is concluded that the rolling cylinder is a potential high-performance heat storage device, with no technical barriers to its further development.

#### **07 ENERGY STORAGE**

A80-50970 The development of thermal energy storage systems exploiting solid-solid phase transitions. A. Addeo, L. Nicolais (Montedison SpA, Centro Ricerche, Naples, Italy), V. Busico, and C. Migliaresi (Napoli, Università, Naples, Italy). Applied Energy, vol. 6, Sept. 1980, p. 353-362. 14 refs. Research supported by the Consiglio Nazionale delle Ricerche.

Selection criteria for thermal accumulation systems are reviewed with emphasis on systems which depend on latent, rather than sensible, heat effects. Novel storage systems based on layer perovskites and polymeric composites are evaluated. These systems employ solid-solid transitions and offer a wide range of transition temperatures. The transition enthalpy values (10-35 cal/g) of these systems are of the same order of magnitude as the transition enthalpies of other recently proposed thermal energy storage systems, e.g. a device using a core of Glauber's salt.

V.L.

A80-51125 Thermal energy storage using saturated salt solutions. M. A. Bell and I. E. Smith (Cranfield Institute of Technology, Cranfield, Beds., England). Energy (UK), vol. 5, Oct. 1980, p. 1085-1090. 7 refs. Research supported by the Science Research Council of England and Commission of the European Communities.

In order to reduce the volume required to store low grade thermal energy in water, various systems using phase change materials (PCMs) have been proposed. However, in order to overcome the poor heat transfer characteristics associated with the solidification of the PCM on heat transfer surfaces, large surface areas need to be provided. This is often achieved by encapsulation in either large or small containers, which has the effect of increasing the cost and reducing the effective energy density. Furthermore PCMs can only accept and release heat at one particular temperature. In an attempt to overcome these limitations thermal energy storage using saturated salt solutions has been examined. The energy density for a number of promising salts has been calculated and confirmed by experiment. Energy density increases of up to 4 times that of water are possible, depending on the salt used and the temperature swing permitted. The deposition of crystals from the solution on heat exchanger surfaces has been overcome by the use of a novel self-cleaning technique. (Author)

A80-51683 An investigation of the thermal energy storage capacity of Glauber's salt with respect to thermal cycling. S. Marks (Delaware, University, Wilmington, Del.). Solar Energy, vol. 25, no. 3, 1980, p. 255-258. 22 refs.

A80-51688 Some chemistry in the Li/SOC12 cell. K. M. Abraham and R. M. Mank (EIC Corp., Newton, Mass.). Electrochemical Society, Journal, vol. 127, Oct. 1980, p. 2091-2096. 29 refs. Grant No. DAAB-07-78-C-0564.

Results of analytical studies aimed at characterizing chemical and electrochemical reactions in Li/SOC12 cells during overdischarge and 'charge' are presented. The studies include: (1) constant-current electrolysis of SOC12/LiAlCl4 solutions and analysis of products by infrared spectrometry; (2) cyclic voltammetry of SOC12/LiAlCl4 solutions; and (3) product analysis from Li/SOC12 cells after overdischarge and constant-current 'charge' using in situ cyclic voltammetry and infrared spectrometry.

V.L.

A80-51690 Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate. I. Epelboin, M. Froment, M. Garreau, J. Thevenin, and D. Warin (CNRS, Groupe de Recherche, Paris, France). (Electrochemical Society, Meeting, Los Angeles, Calif., Oct. 14-19, 1979.) Electrochemical Society, Journal, vol. 127, Oct. 1980, p. 2100-2104. 19 refs. Direction des Recherches, Etudes et Techniques Contract No. 78-34-265-00-480-75-01:

The improvement of the lithium cycling efficiency obtained by substituting an aluminum substrate for a lithium substrate is explained by means of morphological and kinetic studies of the electrodes in the molar solution LiClO4-propylene carbonate. SEM

observations show that the insertion rate of the lithium deposit into aluminum can be sufficiently high so as to avoid dendritic growth; ESCA analysis reveals that propylene carbonate leads to a chemical formation of a polymeric membrane on the electrodes, which is less important on the aluminum than on the lithium substrate. Electrochemical impedance measurements associated with polarization curve data point out that most of the surface is active, giving rise to an exchange current density of about 17 mA/sq cm; these studies also demonstrate that diffusion processes in the passivating layer and in the bulk of the electrode are responsible for the limited lithium cycling performances with the aluminum substrate. (Author)

A80-51698 Resistance rise in sodium-sulphur cells. D. S. Demott (British Railways, Research and Development Div., Derby, England). *Electrochemical Society, Journal*, vol. 127, Oct. 1980, p. 2312-2314. 8 refs.

The causes of resistance increase in sodium-sulphur cells during extended periods of cycling which can be as high as 20 ohm sq cm per 100 cycles are investigated experimentally. Although the mechanism of resistance increase has not been established, it is found that the cause of the observed effects is removed by sodium renewal. Since the effect is found to occur to varying degrees over a range of beta-double-prime-alumina compositions, it is thought to be a contributory factor to the resistance increase.

A80-52974 Transfer function of a sensible-heat storage element in periodic regime (Fonction de transfert d'un element de stockage par chaleur sensible fonctionnant en regime periodique). B. Fourcher and C. Saint-Blanquet (Nantes, Université, Nantes, France). International Journal of Heat and Mass Transfer, vol. 23, Sept. 1980, p. 1251-1262. 11 refs. In French.

This paper deals with the extraction of the mean component of a periodic thermal power (solar energy for example). It is shown that such a filtering may be achieved by introducing a solid sensible-heat thermal storage unit. A theoretical model has been defined for a specific heat storage configuration composed of a number of rectangular cross-section channels for the flowing fluid connected parallel and separated by the solid storage material. The model yields basic physical conclusions for the temperature fluctuations at the exit extremity and makes it possible to define an optimal geometry for the designs. The results are set explicitly for two different fluid-storage material couples: air-alumina and air-refractory brick.

(Author)

N80-28855 Ohio State Univ., Columbus.

A NEW PROBABILISTIC SIMULATION TECHNIQUE FOR MULTIPLE ENERGY STORAGE DEVICES FOR ELECTRIC UTILITY GENERATION SYSTEM EXPANSION PLANNING MODELS Ph.D. Thesis

Brian Manhire 1980 338 p

Avail: Univ. Microfilms Order No. 8015903

A computationally feasible probabilistic production cost model is described which is capable of evaluating the impact on the operating cost of an electric utility of multiple energy storage technologies such as pumped storage hydroelectric, storage batteries, cryogenic storage, flywheels, and gas turbines utilizing compressed air storage. The model is capable of simulating the complex interactions of individual units of each storage technology with the remaining units, both storage and nonstorage, of the power system. Operating characteristics of the various energy storage technologies including forced outage rates, cycle efficiencies, fuel characteristics, and storage capability constraints are considered in the model as well as differences between these characteristics among individual units within each storage technology. The model is oriented toward the Wien Automatic System Planning Package, a widely used generation system expansion planning model. It is also able to simulate individually, multiple generating units whose energy use is preassigned.

Dissert. Abstr.

N80-28866\*# Midwest Research Inst., Kansas City, Mo. THERMAL ENERGY STORAGE SYSTEMS USING FLUIDIZED BED HEAT EXCHANGERS Final Report, Jan. 1979 - Jan. 1980

Tom Weast and Larry Shannon Jun. 1980 209 p (Contracts DEN3-96; EC-77-A-31-1034) (NASA-CR-159868; DOE/NASA/0096-1) HC A10/MF A01 CSCL 10C

A rotary cement kiln and an electric arc furnace were chosen for evaluation to determine the applicability of a fluid bed heat exchanger (FBHX) for thermal energy storage (TES). Multistage shallow bed FBHX's operating with high temperature differences were identified as the most suitable for TES applications. Analysis of the two selected conceptual systems included establishing a plant process flow configuration, an operational scenario, a preliminary FBHX/TES design, and parametric analysis. A computer model was developed to determine the effects of the number of stages, gas temperatures, gas flows, bed materials, charge and discharge time, and parasitic power required for operation. The maximum national energy conservation potential of the cement plant application with TES is 15.4 million barrels of oil or 3.9 million tons of coal per year. For the electric arc furnance application the maximum national conservation potential with TES is 4.5 million barrels of oil or 1.1 million tons of coal per year. Present time of day utility rates are near the breakeven point required for the TES system. Escalation of on-peak energy due to critical fuel shortages could make the FBHX/TES applications economically attractive in the future. É.D.K.

N80-28878# Sandia Labs., Albuquerque, N. Mex. mechanical Subsystems Dept.

MULTIPLE-TANK HIGH TEMPERATURE STORAGE SUB-SYSTEM Summary Report Robert A. Randall Feb. 1980 34 p (Contract EY-76-C-04-0789)

(SAND-79-2056) Avail: NTIS HC A03/MF A01

The design, construction, installation, and testing of a multiple-tank thermal energy storage subsystem at the Midtemperature Solar Systems Test Facility located in Sandia Laboratories, Albuquerque, New Mexico are described. Included are the design requirements and a description of the subsystem. Also discussed are the test procedures and test results to evaluate thermal performance. System costs are listed. Subsequent tests are planned to evaluate control techniques and logic.

N80-28884# General Electric Co., Schenectady, N. Y. Corporate Research and Development.

REGENERATIVE FLYWHEEL ENERGY STORAGE SYSTEM Edward L. Lustanader, Ivan H. Edelfelt, Donald W. Jones, Allan B. Plunkett, Eike Richter, and Fred G. Turnbull [1979] 34 p refs

(Contract W-7405-eng-48)

(UCRL-13982-Rev-1) Avail: NTIS HC A03/MF A01
The development, fabrication, and testing of a regenerative flywheel energy storage and recovery system for a battery/ flywheel electric vehicle of the 3000 lb class are described. The vehicle propulsion system was simulated on a digital computer in order to determine the optimum system operating strategies and establish a calculated range improvement over a nonregenerative, all-electric vehicle: Fabrication of the inductor motor, flywheel, power conditioner, and system control are described. Test results of the system operating over the SAE J227a Schedule D driving cycle are given and are compared to the calculated value. The flywheel energy storage system consists of a solid rotor, synchronous, inductor-type, flywheel drive machine electrically coupled to a dc battery electric propulsion system through a load commutated inverter. The motor/alternator unit is coupled mechanically to a small steel flywheel which provides a portion of the vehicle's accelerating energy and regenerates the vehicle's braking energy.

N80-28924# Martin Marietta Aerospace, Denver, Colo. INTERNALLY INSULATED THERMAL STORAGE SYSTEM **DEVELOPMENT PROGRAM** Final Report

Dec. 1979 172 p refs (Contract EY-76-C-04-0789)

HC A08/MF A01

NTIS

(SAND-80-8175; MCR-79-1369)

NTIS Avail.

A cost effective thermal storage system for a solar central receiver power system using molten salt stored in internally insulated carbon steel tanks was defined. The program was divided into five tasks: (1) testing of internal insulation materials in molten salt: (2) preliminary design of storage tanks, including insulation and liner installation; (3) thermal analysis of internally insulated thermocline tanks; (4) optimization of the storage configuration;

and (5) definition of a subsystem research experiment to demonstrate the system. DOF

N80-28929# Societe Nationale Industrielle Aerospatiale, Les Mureaux (France). Dept. Satellites.
THE SNIAS MAGNETIC BEARING WHEEL [LES ROUES

A PALIERS MAGNETIQUES DE L'AEROSPATIALE)

Claude Rouyer Paris 1979 21 p In FRENCH Presented at Colloq. PROSPACE, Moscow, 10-14 Sep. 1979 (SNIAS-792-421-101) Avail: NTIS HC A02/MF A01

The use of the magnetic bearing for momentum and reaction wheels in satellites is discussed. A description of the specifications and characteristics required is given. The principles of magnetic bearings are given and a specific model is presented. A comparison is made between the advantages and disadvantages of ball and magnetic type bearings. Space and terrestrial application (such as energy storage and recuperation) are foreseen. Author (ESA)

N80-28930# Societe Nationale Industrielle Aerospatiale, Les Mureaux (France). Dept. Etudes Speciales.

PASSIVE RADIALLY CENTERED MAGNETIC SUSPENSION FOR HIGH VELOCITY ROTORS [SUSPENSION MAGNETI-QUE A CENTRAGE RADIAL PASSIF POUR ROTORS A GRANDE VITESSE

Pierre C. Poubeau Paris 1979 28 p refs in FRENCH Presented at SEE Conf. Journees d'Etudes pour les Nouveaux Mater. Magnetiques, Grenoble, 20-21 Apr. 1978 (SNIAS-792-422-109) Avail: NTIS HC A03/MF A01

A suspension system developed for the attitude governing flywheels of satellites is presented. Samarium cobalt magnetic crown pieces assure centering: a single servomechanism stabilizes the axial equilibrium of the rotor. Friction problems are eliminated in this system which enables velocities to be achieved that are only limited by the centrifugal forces experienced by the rotor material. This system is thus associated with rotors made of composite materials. Author (ESA)

N80-29857\*# Honeywell, Inc., Minneapolis, Minn. Technology Strategy Center.

ACTIVE HEAT EXCHANGE SYSTEM DEVELOPMENT FOR LATENT HEAT THERMAL ENERGY STORAGE Final

R. T. LeFrois and A. K. Mathur Apr. 1980 226 p (Contract DEN3-38)

(NASA-CR-159727; DOE/NASA/0038-80/2; HI-79188) Avail: NTIS HC A11/MF A01 CSCL 10C

Five tasks to select, design, fabricate, test and evaluate candidate active heat exchanger modules for future applications to solar and conventional utility power plants were discussed. Alternative mechanizations of active heat exchange concepts were analyzed for use with heat of fusion phase change materials (PCMs) in the temperature range of 250 to 350 C. Twenty-six heat exchange concepts were reviewed, and eight were selected for detailed assessment. Two candidates were selected for small-scale experimentation: a coated tube and shell heat exchanger and a direct contact reflux boiler. A dilute eutectic mixture of sodium nitrate and sodium hydroxide was selected as the PCM from over 50 candidate inorganic salt mixtures. Based on a salt screening process, eight major component salts were selected initially for further evaluation. The most attractive

major components in the temperature range of 250 to 350 C appeared to be NaNO3, NaNO2, and NaOH. Sketches of the two active heat exchange concepts selected for test are given.

N80-29860\* # Jet Propulsion Lab., California Inst. of Tech., Pasadena. Solar Thermal Power Systems.

HIGH TEMPERATURE THERMAL ENERGY STORAGE IN STEEL AND SAND

Robert H. Turner 15 Dec. 1979 93 p Sponsored by NASA and DOE

(NASA-CR-159708: DOE/NASA/0100-79/1: JPL-PUB-80-35) Avail: NTIS HC A05/MF A01 CSCL 10C

The technical and economic potential for high temperature (343 C, 650 F) thermal energy storage in hollow steel ingots, pipes embedded in concrete, and for pipes buried in sand was evaluated. Because it was determined that concrete would separate from pipes due to thermal stresses, concrete was replaced by sand, which is free from thermal stresses. Variations of the steel ingot concept were not cost effective compared to the sand-pipe approach, therefore, the sand-pipe thermal storage unit (TSU) was evaluated in depth to assess the approximate tube spacing requirements consistent with different system performance characteristics and also attendant system costs. For large TSUs which do not require fast response times, the sand-pipe approach offers attractive possibilities. A pipe diameter about 9 cm (3.5 in) and pipe spacing of approximately 25 cm (10 in), with sand filling the interspaces, appears appropriate. Such a TSU system designed for 8 hours charge/discharge cycle has an energy unit storage cost (CE) of \$2.63/kWhr-t and a power unit storage cost (Cp) of \$42/kW-t (in 1977 dollars).

N80-29905# Brown, Boveri und Cie, A.G., Heidelberg (West Zentrales Forschungslab. Germany).

DEVELOPMENT OF SODIUM SULFUR BATTERIES Final

Report

Roland Bauer, Wilfried Fischer, Wilhelm Haar, Bernd Hartmann, Herbert Kleinschmager, Henner Meinhold, and Gert Weddigen Bonn Bundesmin, fuer Forsch, u. Technol. Dec. 1979 126 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-T-79-60: ISSN-0340-7608) HC A07/MF A01: Fachinformationszentrum, Karlsruhe, West Germany DM 26,05

The principal problems in the development of sodium sulfur batteries are essentially solved now that a 10 kWhr experimental battery was tested successfully. Extrapolation of the experimental results permits the conclusion that the properties necessary for application can be defined. The beta-alumina solid electrolyte was optimized with respect to electrical conductivity and lifetime. The sulfur electrode was improved with respect to sulfur utilization and the cathode current collector case with respect to corrosion resistance. Cells of the type being used in an experimental battery (60 to 90 Whr/kg depending on charge/discharge time) were cycled up to 350 times. Capacity declined 3 to 30% during this time, the rate being dependent on casing material. The energy density of cells optimized with respect to weight amounts to about 165 Whr/kg. The first results achieved with the 10 kWh experimental battery are in accordance with results obtained with single cells. Higher energy density, higher lifetime, and better thermal insulation must be achieved. Author (ESA)

N80-29908# Deutsche Automobilgesellschaft m.b.H., Esslingen (West Germany). Forschungslab.

NICKEL HYDROGEN CELL DEVELOPMENT CENTERED ON POSITIVE ELECTRODES WITH HIGH CAPACITY PER UNIT AREA FOR LOAD LEVELING AND TRACTION APPLICA-TIONS Final Report

Guenter Gutmann and Rolf Linkohr Bonn Bundesmin, fuer Forsch. u. Technol. Dec. 1979 108 p refs in GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-T-79-74) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 22,70

Scale-up of single cell storage batteries to adapt the system to electric vehicle and load leveling applications was pursued. The development of a low cost Ni/H2 cell making use of positive electrodes of high capacity per unit area (70 to 120 mAhr/cu cm), for orbiting satellites and super to sealed Ni/Cd cells in energy density and reliability is considered. Results from a heat management study reveal that under traction conditions, cell size must be restriced to 120 Ahr. Feasibility of cells with nonhydrophobic negatives together with positives of 100 to 120 mAhr/cu cm was shown experimentally, best performance data being obtained with 2.2 to 2.6 cu cm/Ahr of electrolyte for a one to two hour discharge rate. Results for two 130 Ahr cells show the limits of thermal capability as built: without additional cooling only 87 percent of the capacity of positives inserted can be taken from the cells. An energy density of 47 Whr/kg is demonstrated at the two to five hour discharge rate. Self discharge is found to be about 8 percent per day. According to materials savings and the reduction in number of stack parts achieved by the cell design, costs are cut to about half that of designs now in use. Author (ESA)

N80-30924# Rocket Research Corp., Redmond, Wash. SULFURIC ACID AND WATER CHEMICAL HEAT PUMP/ CHEMICAL ENERGY STORAGE PROGRAM, PHASE 2-A Final Report

E. C. Clark 1979 132 p refs (Contract EY-76-C-04-0789) (SAND-78-8176: RRC-79-R-727) HC A07/MF A01

NTIS Avail:

A solar charged chemical heat pump/chemical energy storage (solar/CHP/CES) device is described with the ability to utilize solar energy for heat pumping, space cooling, and extended duration thermal energy storage. A study of solar/CHP/CES system economics, system optimization and component testing, and assessment of the ability to commercialize the system is DOE presented.

N80-30927# Argonne National Lab., III. Chemical Engineering

**DEVELOPMENT OF ADVANCED BATTERIES AT ARGONNE** NATIONAL LABORATORY Summary Report, 1979 Apr. 1980 46 p

(Contract W-31-109-eng-38)

(ANL-80-32) Avail: NTIS HC A03/MF A01

The batteries being developed are for electric vehicle propulsion and stationary energy storage applications. The principal cells under investigation at present are of a vertically oriented, prismatic design with one or more inner positive electrodes of FeS or FeS2 facing negative electrodes of Li-Al alloy, and molten LiCI-KCI electrolyte: the cell operating temperature is 400 to 500 C. A small effort on the development of a calcium/metal sulfide cell is also being conducted. A 40 kWh electric vehicle battery was fabricated and delivered for testing. During heat-up, one of the modules failed due to a short circuit. A failure analysis was conducted and the Mark IA program completed. Development work on the next electric vehicle battery (Mark 11) was initiated. Work on stationary energy storage batteries consisted primarily of conceptual design studies. DOE

N80-31270# Jet Propulsion Lab., California Inst. of Tech.,

HYBRID VEHICLE POTENTIAL ASSESSMENT. VOLUME 3: PARALLEL SYSTEMS

S. P. DeGrey 30 Sep. 1979 60 p (Contract EM-78-I-01-4209)

(CONS-4209-T1-Vol-3) Avail: NTIS HC A04/MF A01

The hybrid vehicle type is characterized by arrangement of the heat engine and electric motor in the power train such that a direct mechanical or fluid mechanical power path from both the motor and engine to the wheels is available. Out of the several possible component arrangements that could satisfy these requirements, a configuration in which the engine and motor are mounted in tandem, driving a 4 speed manual transmission, was selected for extensive computer analysis. Simulation of all the identified missions were run for this parallel hybrid configuration. For each mission, the battery mass fraction which is defined as the ratio of the battery mass to the gross vehicle weight (expressed in percent) was varied from 5 to 30%. These vehicles

were designed such that the total energy usage of the battery before cut off would be about 80% of the C/3 discharge rate.

N80-31278# Wisconsin Univ. - Madison. Engineering Experiment Station.

FLYWHEEL ENERGY MANAGEMENT SYSTEMS FOR IMPROVING THE FUEL ECONOMY OF MOTOR VEHICLES ..... N. H. Beachley and A. A. Frank Aug. 1979 195 p refs

(Contract DOT-OS-60177)

(PB80-175300; DOT/RSPA/DPB-50-79/1) Avail: NTIS HC A09/MF A01 CSCL 13F

The experimental flywheel vehicle has demonstrated 32 mpg over the EPA-CVS Federal Urban Driving Cycle at an inertia weight of 2750 lb. Calculations based on experimental engine data indicate that federally mandated emissions levels could be achieved with little degradation in fuel economy. The computer simulation programs developed have been verified by experi-

N80-31892# Avco Systems Div., Wilmington, Mass. HIGH ENERGY DENSITY COMPOSITE FLYWHEEL PRO-GRAM Final Report, Jun. 1976 - May 1980

A. D. Sapowith, A. L. Gurson, and J. A. McElman 30 May 1980 155 p refs

(Contract DAAG53-75-C-0269)

(AD-A087076; AVSD-0170-80-RR)

Avail: NTIS

HC A08/MF A01 CSCL 11/4

A bi-directional composite flywheel was instrumented with strain gages and tested to destruction. The flywheel was designed to exhibit constant stress in both radial and circumferential directions for all radial positions. Strain gage data verified this design. The burst speed was 38,741 rpm representing a specific energy level of 32.3 Wh/lb. The flywheel was constructed of Kevlar composite, had an outside diameter of 19.5 in., an axial thickness of 1.5 in. and weighed 18.6 lbs. Premature failure was initiated at the inside diameter by excessive pressure exerted by a metal hub. A polyacrylate hub design, with test data, is presented to solve this problem. **GRA** 

N80-32299\*# Battelle Columbus Labs., Ohio. DESIGN STUDY OF STEEL V-BELT CVT FOR ELECTRIC VEHICLES Final Report

J. C. Swain, T. A. Klausing, and J. P. Wilcox Jun. 1980 131 p

(Contracts DEN3-116; EC-77-A-31-1044)

(NASA-CR-159845; DOE/NASA/0116-80/1) Avail: NTIS HC A07/MF A01 CSCL 13F

A continuously variable transmission (CVT) design layout was completed. The intended application was for coupling the flywheel to the driveline of a flywheel battery hybrid electric vehicle. The requirements were that the CVT accommodate flywheel speeds from 14,000 to 28,000 rpm and driveline speeds of 850 to 5000 rpm without slipping. Below 850 rpm a slipping clutch was used between the CVT and the driveline. The CVT was required to accommodate 330 ft-lb maximum torque and 100 hp maximum transient. The weighted average power was 22 hp, the maximum allowable full range shift time was 2 seconds and the required lift was 2600 hours. The resulting design utilized two steel V-belts, in series to accommodate the required wide speed ratio. The size of the CVT, including the slipping clutch, was 20.6 inches long, 9.8 inches high and 13.8 inches wide. The estimated weight was 155 lb. An overall potential efficiency of 95 percent was projected for the average power condition.

Author

N80-32856\*# Texas Univ., Austin. Center for Electromechan-

A STUDY OF THE APPLICABILITY/COMPATIBILITY OF INERTIAL ENERGY STORAGE SYSTEMS TO FUTURE SPACE MISSIONS Final Report

William F. Weldon Aug. 1980 139 p refs Sponsored in part by Texas Atomic Energy Research Foundation

(Contracts NAS7-100; JPL-955679) (NASA-CR-163584: JPL-9950-413) HC A07/MF A01 CSCL 10C

Avail: NTIS

The applicability/compatibility of inertial energy storage systems like the homopolar generator (HPG) and the compensated pulsed alternator (CPA) to future space missions is explored. Areas of CPA and HPG design requiring development for space applications are identified. The manner in which acceptance parameters of the CPA and HPG scale with operating parameters of the machines are explored and the types of electrical loads which are compatible with the CPA and HPG are examined. Potential applications including the magnetoplasmadynamic (MPD) thruster, pulsed data transmission, laser ranging, welding and electromagnetic space launch are discussed.

N80-32862# Naval Research Lab., Washington, D. C. ENERGY STORAGE AS HEAT-OF-FUSION IN CONTAINER-IZED SALTS. REPORT ON ENERGY STORAGE BOILER **TANK Interim Report** 

T. A. Chubb, J. J. Nemecek, and D. E. Simmons 27 Jun. 1980 110 p refs

(Contract EC-77-A-31-1024; RR0240145)

(AD-A087753; AD-E000495; NRL-MR-4267) Avail: NTIS

HC A06/MF A01 CSCL 10/3

This report is concerned with energy storage based on heat-of-fusion in containerized salt. The 'energy storage boiler tank' uses evaporation and condensation of a heat transfer fluid to provide heat transfer into and out of stacked cans of salt. The 'energy storage superheater tank' uses a network of alkali metal heat pipes to distribute heat throughout a building filled with salt cans. It uses a radiation to transfer energy to and from stacked cans of salt. The paper summarizes the rationale for energy storage in containerized salt, it discusses salt availability, salt processing, container requirements, can technology and heat transfer fluid degradation problems. These discussions lead to estimates of energy storage system costs. The Naval Research Laboratory is building a 2 MWht proof-ofconcept energy storage boiler tank. Laboratory investigations studying the compatibility of the heat transfer fluid with the molten storage salt are described, along with measurements of temperature drops associated with the energy input process. An assessment of the current status of the energy storage boiler tank is presented.

N80-32873# Battelle Pacific Northwest Labs., Richland, Wash. POROUS MEDIA EXPERIENCE APPLICABLE TO FIELD EVALUATION FOR COMPRESSED AIR ENERGY STOR-AGE

R. D. Allen and P. J. Gutknecht Jun. 1980 98 p refs (Contract DE-AC06-76RL-01830) (PNL-3294) Avail: NTIS HC A05/MF A01

A survey is presented of porous media field experience that may aid in the development of a compressed air energy storage field demonstration. Related experience embraces technologies of natural gas, thermal energy, and geothermal and hydrogen storage. Natural gas storage technology lends the most toward compressed air storage development, keeping in mind the respective differences between stored fluids, physical conditions, and cycling frequencies. Both fluids are injected under pressure into an aquifer to form a storage bubble confined between a suitable caprock structure and partially displaced ground water. State-of-the-art information is summarized as the necessary foundation material for field planning. Suggested ranges are given for injection air temperature and reservoir pressure.

N80-32879# Oak Ridge National Lab., Tenn. THERMAL ENERGY STORAGE FOR BUILDING HEATING AND COOLING APPLICATIONS Technical Progress Report. Apr. 1979 - Mar. 1980

J. F. Martin and H. W. Hoffman Jun. 1980 65 p refs (Contract W-7405-eng-26)

(ORNL-TM-7319) Avail: NTIS HC A04/MF A01

The ORNL program in thermal energy storage (TES) over the past year is reported. The program consists of developing sensible and latent heat technologies to meet the single goal of reduction in oil and gas consumption for residential and space

## **07 ENERGY STORAGE**

conditioning. Three specific application elements were addressed: utility load management, solar energy applications; and conservation. Programs (both completed and ongoing) are summarized, and their relationship to the specific implementation plan are given. The program completed a transition from low temperature storage development including seasonal storage in natural aquifers to TES development for building heating and cooling applications.

N80-32897# Applied Physics Lab., Johns Hopkins Univ., Laurel,

LOW-COST FLYWHEEL DEMONSTRATION PROGRAM Final Report, 1 Oct. 1977 - 31 Dec. 1979

D. W. Rabenhorst, T. R. Small, and W. O. Wilkinson Apr. 1980 109 p. refs

(Contract DE-ACO1-77ET-26931)

(DOE/ET-26931/T1; SDO-5540) Avail:

HC AO6/MF AO1

The Applied Physics Laboratory/Department of Energy Low Cost Flywheel Demonstration Program was initiated and all primary objectives were successfully achieved as follows: demonstration of a full-size, 1 kWh flywhel having an estimated cost in large volume production of approximately \$50/kWh: development of a ball bearing system having losses comparable to the losses in a totally magnetic suspension system: and successful and repeated demonstration of the low cost flywheel in a complete flywheel energy storage system based on the use of ordinary house voltage and frequency. Application of the experience gained in the hardware program to project the system design into a complete, full scale, 30 kWh home type flywheel energy storage system was also completed.

N80-32898# Texas A&M Univ., College Station. Dept. of Mechanical Engineering.

RESEARCH AND DEVELOPMENT FOR INERTIAL ENERGY STORAGE BASED ON A FLEXIBLE FLYWHEEL Final Report

John M. Vance Jun. 1980 50 p refs Prepared for Sandia Labs., Albuquerque, N. Mex.

(Contract DE-ACO4-76DP-00789)

(SAND-79-7097) Avail: NTIS HC A03/MF A01

A design concept for a nonrigid energy storage flywheel suitable for home or farm use was investigated. The distinguishing feature of this flexible flywheel is its construction from high strength fibers (such as synthetic rope) with no bonding agent. The flexible flywheel is self balancing safe, has a high energy density capability (60 Wh/lb), and should be simple and economical to manufacture. A gimbal support system which stabilizes the flywheel without the need for a squeeze film damper was designed, analyzed, and tested. The conceptual design was developed for a flexible flywheel energy storage system suitable for interfacing with a small scale solar energy source. Cost estimates were prepared for the system in the 10 KWh and 50 KWh sizes.

N80-32899# Battelle Nortwest Labs., Richland, Wash. SEASONAL THERMAL ENERGY STORAGE Program Progress Report, Apr. - Dec. 1979

J. E. Minor Mar. 1980 59 p Prepared in cooperation with Tennessee Valley Authority, Chattanooga: Texas A and M Univ., College Station: Washington State Univ., Pullman; Auburn Univ., Ala.; California Univ., Lawrence Berkeley Lab.; ORNL, Tenn.; Terra Tek, Inc., Salt Lake City

(Contract DE-AC06-70RL-01830)

(PNL-3322) Avail: NTIS HC A04/MF A01

The Seasonal Thermal Energy Storage (STES) Program demonstrates the economic storage and retrieval of thermal energy on a seasonal basis, using heat or cold available from waste or other sources during a surplus period to reduce peak period demand, reduce electric utilities peaking problems, and contribute to the establishment of favorable economics for district heating and cooling systems for commercialization of the technology. The STES Program utilizes ground water systems (aquifers) for thermal energy storage. The STES Program is divided into an Aquifer Thermal Energy Storage (ATES) Demonstration Task for demonstrating the commercialization potential of aquifer thermal

energy storage technology using an integrated system approach to multiple demonstration projects and a parallel Technical Support Task designed to provide support to the overall STES Program, and to reduce technological and institutional barriers to the development of energy storage systems prior to significant investment in demonstration or commercial facilities.

N80-32900# Brookhaven National Lab., Upton, N. Y. National Center for Analysis of Energy Systems.

COSTING METHODOLOGIES FOR ENERGY SYSTEMS

Jack Allentuck, Vinod Mubayi, and Ann W. Reisman Nov. 1979 23 p refs Presented at Conf. on Long-Term Energy Resources, Montreal, 3 Dec. 1979

(Contract DE-AC02-76CH-00016)

(BNL-27603; CONF-791216-3)

HC A02/MF A01

Avail: NTIS

The problem of devising a methodology for arriving at costs of systems which may be used to compare alternative sources was addressed. The basic elements of such a methodology were examined. Diverse subjects such as resource supply curves, experience and learning, and the cost of environmental pollution were investigated.

N80-32907# California Univ., Livermore. Lawrence Livermore

COMPARATIVE ANALYSIS OF ALUMINUM-AIR BATTERY PROPULSION SYSTEMS FOR PASSENGER VEHICLES

J. D. Salisbury, E. Behrin, M. K. Kong, and D. J. Whisler 29 Feb. 1980 103 p refs

(Contract W-7405-eng-48)

(UCRL-52933) Avail: NTIS HC A06/MF A01

Three electric propulsion systems using an aluminum air battery were analyzed and compared to the internal combustion engine (ICE) vehicle. The engine and fuel systems of a representative five passenger highway vehicle were replaced conceptually by each of the three electric propulsion systems. The electrical vehicles were constrained by the computer simulation to be equivalent to the ICE vehicle in range and acceleration performance. The vehicle masses and aluminum consumption rates were then calculated for the electric vehicles and these data were used as figures of merit. The Al-air vehicles analyzed were (1) an Al-air battery only electric vehicle; (2) an Al-air battery combined with a nickel zinc secondary battery for power leveling and regenerative braking; and (3) an Al-air battery combined with a flywheel for power leveling and regenerative braking. All three electric systems compared favorably with the ICE vehicle.

N80-32917# Energy Development Associates, Madison Heights, Mich.

DEVELOPMENT OF THE ZINC-CHLORIDE BATTERY FOR UTILITY APPLICATIONS Progress Report, 1 Apr. 1978 -31 Mar. 1980

May 1980 407 p refs

(EPRI-EM-1417) Avail: NTIS HC A18/MF A01

Significant accomplishments were: development of a data base on the density, conductivity, viscosity, chlorine solubility, and the zinc transference number for ZnCl2-KCl-NaCl electrolytes; development of a model describing the hydrodynamic phenomena occurring between individual zinc and chlorine electrodes during charge: demonstration of cell electrochemical energy efficiencies of 74% for delivered capacity densities of 500 Wh/cm 2, completion of reliability studies for 100 MWh battery plants that discuss quantitatively plant availability and electricity cost in terms of module failure rate, invention of a module bypass switch concept that isolates a failed module in a series connected string and thereby avoids string outage. A computer model for module operation was also developed that allows prediction of the effects of component changes on module performance. DOE

N80-32940# California Univ., Livermorè. Lawrence Livermore Lab

ANALYSIS OF ALUMINUM AIR BATTERY PROPULSION SYSTEMS FOR PASSENGER VEHICLES

J. D. Salisbury and E. Behrin 1 May 1980 10 p refs Presented at 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 17-22 Aug. 1980

(Contract W-7405-eng-48) (UCRL-83824; CONF-800806-15) HC A02/MF A01

Avail:

NTIS

The performance characteristics of three electric propulsion systems based on the aluminum air(AL-air) battery were analyzed and compared to the internal combustion engine (ICE). In this comparison, the engine and fuel systems of a current five passenger vehicle were conceptually replaced by three Al-air systems; (1) an Al-air battery only system; (2) an Al-air battery combined with a nickel-zinc secondary battery for power leveling; and (3) an Al-air battery combined with a flywheel power leveler. Performance characteristics such as the average consumption rate of Al metal for the selected drive cycle, vehicle mass, and power system mass were determined for each Al-air propulsion system. Estimates of initial vehicle and life cycle costs of Al-air battery only vehicles indicate that all three systems can achieve performance and operation costs comparable to an ICE vehicle, and that the initial cost of Al-air battery only vehicles can approach the cost of ICE vehicles but at reduced power

N80-32941# California Univ., Livermore. Lawrence Livermore Lab.

## ALUMINUM AIR BATTERY FOR ELECTRIC VEHICLE PROPULSION

John F. Cooper, Robert V. Homsy, and Jerry H. Landrum 1980 10 p refs Presented at 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 18-22, Aug. 1980 Submitted for publication (Contract W-7405-eng-48)

(UCRL-84443; CONF-800806-19)

NTIS

HC A02/MF A01

Aluminum air battery development and the use of aluminum as a recyclable electrochemical fuel are discussed. The battery combines high specific energy (above 300 Wh/kg) and specific power (150 to 200 W/kg) with the capability of rapid refueling by addition of reactants. The objective is a commercially feasible, general purpose electric vehicle. Progress is reported in the scale up of aluminum air single cells to the automotive scale (0.1 m2 anodes) and in the development of a hydrargillite crystallizer, which is required to control electrolyte composition. The total cost and energy required to produce aluminum, and projected consumption by electric vehicles indicates that the aluminum air powered electric vehicle is potentially competitive with advanced automobiles using synthetic liquid fuels.

N80-32948# Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

PERFORMANCE OF STORAGE WALLS WITH HIGHLY CONDUCTIVE COVERING PLATES AND CONNECTING FILMS

Joseph K. E. Ortega, Carl E. Bingham, and J. Michael Connolly . May 1980 9 p. refs

(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042) (SERI/TP-721-574) Avail: NTIS HC A02/MF A01

The thermal behavior of a storage wall, constructed of concrete with highly conductive plates and connecting vertical fins, is investigated. The results demonstrate that, during the charging mode, the amount of energy released from the front surface is significantly reduced. A portion of the saved energy is stored for future discharge, but a large portion is transferred to the back surface and released. A selective front surface reduces the energy released from the front surface, and this energy is stored. By properly selecting the fin spacing, plate-fin thickness, and plate-fin thermal conductivity, the rate and direction of thermal discharge can be controlled. The improved heat transfer capability and added thermal control provide new alternatives for interzonal heat transfer and multizone passive building designs.

N80-32949# Midwest Research Inst., Golden, Colo. Passive Technology Branch.

COMPUTER MODELING OF THERMAL STORAGE WALLS
J. Michael Connolly, Carl E. Bingham, and Joseph K. E. Ortega
May 1980 7 p refs

(Contracts DE-AC02-77CH-00178; EG-77-C-01-4042) (SERI/TP-721-610) Avail: NTIS HC A02/MF A01 The modeling of the three dimensional heat transfer characteristics of thermal storage walls and the effect of nonuniform irradiation is investigated. Depending on how much of the wall is irradiated, a small error in energy storage is introduced with the one dimensional, uniform irradiation assumption. The results show that these assumptions, currently used in most passive design codes, are adequate to predict the thermal energy storage characteristics. However, the temperature distribution along the surface of the wall is much different when the nonuniform irradiation case is considered. The addition of a highly conductive metal cover on the front surface of the wall does not significantly improve the thermal energy storage characteristics of the wall when the wall is partially irradiated. A selective radiation coating reduces front losses and improves the energy storage capacity of the wall 9 to 13%.

N80-32955# Midwest Research Inst., Golden, Colo.
MODEL OF DIRECT CONTACT HEAT TRANSFER FOR
LATENT HEAT ENERGY STORAGE

Michael E. Cease May 1980 8 p refs Presented at the 15th Intersoc. Energy Conversion Eng. Conf., Seattle, 18-22 Aug. 1980

(Contracts EG-77-C-01-4042; DE-AC02-77CH-00178) (SERI/TP-631-567; CONF-800806-27) Avail: NTIS HC A02/MF A01

In a direct contact heat transfer system, an immiscible fluid was bubbled through the storage media and heat was transferred between the phases as the droplets rose. An analytical model is presented for predicting the temperature of the rising droplets from information in the literature. The drop size was calculated from empirical correlations in the jetting formation region and rise velocity was characterized by a creeping-flow surface cell model which accounts for the hindering effects of neighboring droplets. The viscosity of the crystallizing solution in the rise velocity equation was approximated by an expression for concentrated suspensions, where the percentage of solids was taken as the percentage of crystallization. Dispersed phase holdup was predicted with the rise velocity. Calculation of the rate of heat transfer to the dispersed immiscible fluid droplets was based on three different internal hydrodynamic approximations: rigid, internally circulating, and wall-mixed spheres. DOE

N80-32967# National Technical Information Service, Springfield,

LITHIUM BATTERIES. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1978 - Jun. 1980

Diane M. Cavagnaro Jul. 1980 162 p refs Supersedes NTIS/PS-79/0675; NTIS/PS-79/0660 (PB80-812399; NTIS/PS-79/0675; NTIS/PS-78/0660) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10C

Federally funded research on design, development, components, testing corrosion, electrolytes, sealing, hazards of lithium cells are presented. Batteries studied include lithium organic cells, lithium sulfur cells, lithium water air cells, and lithium nickel fluoride cells. Applications cover use in spacecraft, electric vehicles, off peak energy storage, and forklift trucks. This updated bibliography contains 151 citations, 57 of which are new entries to the previous edition.

N80-32968# National Technical Information Service, Springfield, Va.

LITHIUM BATTERIES. CITATIONS FROM THE ENGINEER-ING INDEX DATA BASE Progress Report, 1970 - Jun. 1980

Diane M. Cavagnaro Jul. 1980 290 p Supersedes NTIS/PS-79/ 0676; NTIS/PS-78/0661

(PB80-812407; NTIS/PS-79/0676; NTIS/PS-78/0661) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10C

Studies on design, development, components, corrosion, and harzards are included in the compilation of worldwide research. Lithium batteries with sulfides, chlorine, thionyl chloride, organic compounds, and water are cited. Applications cover use of lithium cells in pacemakers, spacecraft, electric vehicles, and off peak energy storage. This updated bibliography contains 283 citations, 60 of which are new entries to the previous edition.

N80-33473\* # National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

**ELECTROCHEMICAL ORBITAL ENERGY STORAGE (ECOES) TECHNOLOGY PROGRAM** 

Hoyt McBryar In NASA. Lewis Space Flight Center Synchronous Energy Technol. Sep. 1980 p 81-95

Avail: NTIS HC A07/MF A01 CSCL 10C

The versatility and flexibility of a regenerative fuel cell power and energy storage system is considered. The principal elements of a Regenerative Fuel Cell System combine the fuel cell and electrolysis cell with a photovoltaic solar cell array, along with fluid storage and transfer equipment. The power output of the array (for LEO) must be roughly triple the load requirements of the vehicle since the electrolyzers must receive about double the fuel cell output power in order to regenerate the reactants (2/3 of the array power) while 1/3 of the array power supplies the vehicle base load. The working fluids are essentially recycled indefinitely. Any resupply requirements necessitated by leakage or inefficient reclamation is water - an ideal material to handle and transport. Any variation in energy storage capacity impacts only the fluid storage portion, and the system is insensitive to A.R.H. use of reserve reactant capacity.

N80-33857\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TOROIDAL CELL AND BATTERY Patent Application

William J. Nagle, inventor (to NASA) Filed 28 Mar. 1980

(NASA-Case-LEW-12918-1; US-Patent-Appl-SN-134855) Avail: NTIS HC A02/MF A01 CSCL 10C

A toroidal cell is disclosed which includes a wound core disposed within a pair of toroidal channel shaped electrodes separated by nylon insulator. The shape of the case electrodes of this cell allows one doughnut shaped surface and the inner cylindrical case wall to be used as an electrode and a second planar doughnut shaped surface and the outer cylindrical case wall to be used as another electrode. Connectors may be used to stack two or more toroidal cells together by connecting the entire surface area of the electrode of one cell to the entire surface area of the electrode of a second cell. The central cavity of each toroidal cell may be used as a conduit for pumping a fluid through the toroidal cell to thereby cool the cell.

N80-33906# Department of National Defence, Ottawa (Ontario). Energy Conversion Div.

EVALUATION OF CRANKING CHARACTERISTICS OF COMMERCIALLY AVAILABLE BATTERIES BETWEEN ROOM TEMPERATURE AND -40 C

Louis Brossard and R. W. Gorman Dec. 1979 23 p refs In **ENGLISH**; FRENCH summary

(AD-A080614: DREO-TN-79-30)

HC A02/MF A01 CSCL 10/3

Avail: NTIS

The cranking characteristics of three brands of commercially available batteries (GROUP 24) were measured between room temperature (RT) and -40 C. They were fully recharged at RT before each discharge which was carried out at constant current corresponding to the 3 C to 4 C rates. Under the same experimental conditions, the behavior on discharge of these batteries was found to be very similar. The only significant differences observed concerned the increase in internal battery temperature resulting from a discharge. GRA

N80-33908# Eagle-Picher Industries, Inc., Joplin, Mo. Electron-

NICKEL-ZINC BATTERIES FOR RPV APPLICATIONS Interim Technical Report, 15 Nov. 1978 - 15 Dec. 1979

Donna Dappert Wright-Patterson AFB, Ohio 1980 90 p

(Contract F33615-78-C-2058; AF Proj. 3145)

(AD-A088594; AFWAL-TR-80-2050)

NTIS Avail:

HC A05/MF A01 CSCL 10/3

Interim results are presented for a program dealing with the placement of nickel zinc batteries in specific military applications, namely the BQM-34A and the PQM-102 Remotely Piloted Vehicles. The nickel zinc system was chosen for these applications because RPV's demand a high quality secondary battery that offers a compromise between long life (calendar and cycle) and low zinc system, calendar and cycle life testing of the two candidate batteries, qualification testing, and flight testing in operational RPV's. Test results of developmental cells and batteries include cycle life testing of various separator materials, high rate/low temperature discharges with various types of nickel electrodes, zinc electrode substrate, and charging methods. Calendar and cycle life testing is underway which will demonstrate the ability of the nickel zinc system to be routinely cycled over an extended period of time.

N80-33909# Applied Physics Lab., Johns Hopkins Univ., Laurel,

LOW-COST FLYWHEEL DEMONSTRATION PROGRAM Final Report, 1 Oct. 1977 - 31 Dec. 1979

D. W. Rabenhorst, T. R. Small, and W. O. Wilkinson Apr. 1980 111 p refs

(Contract EC-77-C-01-5085)

(CONS-5085-T2) Avail: NTIS HC A06/MF A01

All primary objectives were successfully achieved as follows: demonstration of a full-size, 1 kWh flywheel having an estimated cost in large-volume production of approximately \$50/kWh; development of a ball-bearing system having losses comparable to the losses in a totally magnetic suspension system; successful and repeated demonstration of the low-cost flywheel in a complete flywheel energy-storage system based on the use of ordinary house voltage and frequency; and application of the experience gained in the hardware program to project the system design into a complete, full-scale, 30 kWh home-type flywheel energy-DOE storage system.

N80-33923# National Technical Information Service, Springfield,

LEAD BATTERIES. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Jun. 1980

Diane M. Cavagnaro Jul. 1980 204 p Supersedes NTIS/PS-79/ 0780 and NTIS/PS-78/0689

(PB80-813363; NTIS/PS-79/0780; NTIS/PS-78/0689), Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10C

The design, development, components, fabrication, chemistry, and testing of lead batteries are cited in this compilation of federally-funded research. Specific applications for spacecraft, consumer products, and electric vehicles are covered. Studies on lead recovery from battery scrap are covered. Several abstracts on lead toxicity in industrial plants are also cited.

N80-33924# National Technical Information Service, Springfield,

LEAD BATTERIES. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1977 - Jun. 1980 Diane M. Cavagnaro Jul. 1980 159 p Supersedes NTIS/PS-79/ 0782 and NTIS/PS-78/0690

(PB80-813371: NTIS/PS-79/0782; NTIS/PS-78/0690) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10C

Worldwide research on lead battery components, charging, corrosion, and testing is cited. The majority of studies concern battery use in electric vehicles. Studies on lead recovery from battery scrap and air pollution at battery factories are also GRA

## 08 **GENERAL**

A new era in technology; Proceedings of the A80-51926 Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980. Congress sponsored by the Canaveral Council of Technical Societies. Cocoa Beach, Fla., Canaveral Council of Technical Societies, 1980, 400 p. \$30.

The topics presented are a Shuttle update, the monitoring of the environment and natural resources, payloads, space technology applications, international activities in space, and terrestrial energy systems. Particular consideration is given to mixed mode missions in the Space Transportation System, a real-time hyperbolic system for the detection and location of thunderstorms, a review of the Canadian Space Program, and the DOE Ocean Energy Program. B.J.

A80-53568 Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979. Conference sponsored by the American Institute of Chemical Engineers. Edited by R. W. Lyczkowski (California, University, Livermore, Calif.). AIChE Symposium Series, vol. 75, no. 189, 1979. 323 p.

The problems discussed at the conference include uncertainty analysis in heat transfer, solidification and melting heat transfer, nonequilibrium interface transport phenomena, and process heat transfer. Other reports deal with direct contact heat transfer, solar energy heat transfer, recovery and utilization of waste heat, and enhanced heat transfer.

N80-28680# National Technical Information Service, Springfield, Va.

HEAT PIPES. CITATIONS FROM THE NTIS DATA BASE Progress Report, Mar. 1976 - Mar. 1979

William E. Reed Apr. 1980 254 p (PB80-809940) Avail: NTIS HC \$30.00/MF \$30.00 CSCL

Theory, design, fabrication, testing, and operation of heat pipes are presented in these Federally-sponsored research reports. Applications are described in the areas of heating and air conditioning, power generation, electronics cooling, spacecraft, nuclear reactors, cooling engines, and thermodynamics. This updated bibliography contains 247 abstracts, none of which are new entries to the previous edition.

N80-28681# National Technical Information Service, Springfield,

HEAT PIPES. CITATIONS FROM THE NTIS DATA BASE

Progress Report, Apr. 1979 - Apr. 1980
William E. Reed Apr. 1980 77 p Supersedes NTIS/PS-79/
0298; NTIS/PS-78/0302

(PB80-809957; NTIS/PS-79/0298; NTIS/PS-78/0302) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Theory, design, fabrication, testing, and operation of heat pipes are presented in these Federally sponsored research reports. Applications are described in the areas of heating and air conditioning, power generation, electronics cooling, spacecraft, nuclear reactors, cooling engines, and thermodynamics. This updated bibliography contains 70 abstracts, all of which are new entries to the previous edition.

N80-28682# National Technical Information Service, Springfield,

HEAT PIPES. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, Apr. 1977 - Mar. 1979

William E. Reed Apr. 1980 215 p (PB80-809965) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Research reports covering the thermodynamics, design, fabrication, and applications of heat pipes are cited from worldwide literature. Applications are described in the areas of electronics cooling, spacecraft thermal control, heat exchangers, heating and refrigeration, and waste heat utilization. This updated bibliography contains 208 abstracts, none of which are new entries to the previous edition.

N80-28683# National Technical Information Service, Springfield,

HEAT PIPES. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, Apr. 1979 - Mar. 1980 William E. Reed Apr. 1980 132 p Supersedes NTIS/PS/0299;

NTIS/PS-78/0304

(PB80-809973; NTIS/PS-79/0299; NTIS/PS-78/0304) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 13A

Research reports covering the thermodynamics, design, fabrication, and applications of heat pipes are cited from worldwide literature. Applications are described in the areas of electronics cooling, spacecraft thermal control, heat exchangers, heating and refrigeration, and waste heat utilization. This updated bibliography contains 125 abstracts, all of which are new entries to the previous edition. GRA

N80-28919# Department of Energy, Washington, D. C. Office of Current Reporting.

INTERNATIONAL ENERGY INDICATORS

Elizabeth K. Bauer, ed. Mar. 1980 30 p

(DOE/IA-0001T/3(80)) Avail: NTIS HC A03/MF A01

For the international sector, a table of data is first presented followed by corresponding graphs of the data for the following: (1) Iran: crude oil capacity, production, and shut in, 1974 to February 1980; (2) Saudi Arabia (same as Iran); (3) OPEC (ex-Iran and Saudi Arabia); capacity, production, and shutin, 1974 to January 1980; (4) non-OPEC Free World and US production of crude oil, 1973 to January 1980; (5) oil stocks: Free World, US, Japan, and Europe (landed), 1973 to 1979; (6) petroleum consumption by industrial countries, 1973 to October 1979; (7) USSR crude oil production, 1974 to February 1980: (8) Free World and US nuclear generation capacity, 1973 to January 1980. For the United States, the same data format is used for the following: US imports of crude oil and products 1973 to January 1980; landed cost of Saudi Arabia crude oil in current and 1974 dollars, 1974 to October 1979; US trade in coal, 1973 to 1979; summary of US merchandise trade, 1976 to January 1980; and US energy/GNP ratio (in 1972 dollars), 1947 to 1979.

N80-29694# Committee on Commerce, Science, and Transportation (U. S. Senate).

LASER TECHNOLOGY: DEVELOPMENT AND APPLICA-TIONS

Washington GPO 1980 273 p refs Hearings before the Subcomm. on Sci., Technol., and Space of the Comm. on Com., Sci., and Transportation, 96th Congr., 1st and 2nd Sess., 12 and 14 Dec. 1979, 8 and 12 Jan. 1980

(GPO-59-826) Avail: Subcommittee on Science, Technology and Space

An overview of developments and applications in laser technology is given with emphasis on peaceful uses of high energy laser technology. Space vehicle propulsion, remote sensing from space to monitor the Earth's atmosphere, oceans, and land masses, communications with very high data rates over interplanetary distances, and isotope separation and fusion to improve generation of electrical power are among the topics discussed. Potential military applications of high energy lasers weapons discussed include instaneous kill of hostile targets, such as ballistic missiles, and strategic bombers. J.M.S.

N80-31269\*# National Aeronautics and Space Administration, Washington, D. C. NASA PROGRAM PLAN Fiscal Years, 1981 - 1985 Jan. 1980 233 p

Avail: NTIS HC A11/MF A01 CSCL 05A

Major facts are given for NASA'S planned FY-1981 through FY-1985 programs in aeronautics, space science, space and terrestrial applications, energy technology, space technology, space transportation systems, space tracking and data systems, and construction of facilities. Competition and cooperation, reimbursable launchings, schedules and milestones, supporting research and technology, mission coverage, and required funding are considered. Tables and graphs summarize new initiatives, significant events, estimates of space shuttle flights, and major missions in astrophysics, planetary exploration, life sciences, environmental and resources observation, and solar terrestrial investigations. The growth in tracking and data systems capabilities is also depicted.

N80-32296# Council on Environmental Quality, Washington, D.C.

THE GLOBAL 2000 REPORT TO THE PRESIDENT. ENTERING THE TWENTY-FIRST CENTURY. VOLUME 2: THE TECHNICAL REPORT

1980 775 p refs 2 Vol.

Avail: SOD HC

Changes in pollution, climate, technology, Earth resources, energy, and the environment until the end of the century as projected by U.S. Government agencies using their most frequently employed long term planning models and analytical tools are discussed. A sequential approach was used to obtain a measure of self consistency, coherence, and interrelationship so as to provide an integrated global model which reflects the implications if current U.S. policies remain unchanged. Each of the models used is described and other global models are examined and compared with the global model developed.

A.R.H.

N80-32297 Societe Nationale Industrielle Aerospatiale. Les Mureaux (France). Div. Systemes Balistiques et Spatiaux. EXAMPLE OF A POLICY AIMED AT INCREASING THE VALUE OF SPIN-OFFS FROM SPACE TECHNOLOGY IN OTHER FIELDS [EXEMPLE D'UNE POLITIQUE DE VALORISATION DE RETOMBES TECHNOLOGIQUES SPATIALES DANS D'AUTRES DOMAINES]

Didier G. Compard Paris 1980 36 p In FRENCH Presented at Intern. Colloq. on the Econ. Effects of Space and Other Adv. Technol., Strasbourg, 28-30 Apr. 1980 (SNIAS-801-422-101) Avail: NTIS HC A03

Emphasis is given to applications derived from space systems, launching devices and ballistic motors. The underlying philosophy is presented together with the objectives sought. These applications concern energy (storage facilities, off-shore oil installations, nuclear and solar power), medicine, vehicle breaking systems, new materials, some specific technologies (extraction of metals, chemical synthesis, drilling), and safety (particularly in aeronautics. Special studies including the design and demonstration of systems for the chemical and petroleum industries, as well as software systems for ships and other proposes are also described. Some concrete examples are treated. Economics aspects are discussed together with expected developments.

Author (ESA)

N80-32869# Kilkeary, Scott and Associates, Inc., Arlington,

DOCUMENTATION OF VOLUME 3 OF THE 1978 ENERGY INFORMATION ADMINISTRATION ANNUAL REPORT TO CONGRESS Annual Report

29 Feb. 1980 325 p refs (Contract DE-AC01-79EI-10456)

(DOE/EIA-CR-0456) Avail: NTIS HC A14/MF A01

In a preliminary overview of the projection process, the relationship between energy prices, supply, and demand is addressed. Topics treated in detail include a description of energy economic interactions, assumptions regarding world oil prices, and energy modeling in the long term beyond 1995. Subsequent sections present the general approach and methodology underlying the forecasts, and define and describe the alternative projection series and their associated assumptions. Short term forecasting, midterm forecasting, long term forecasting of petroleum, coal, and gas supplies are included. The role of nuclear power as an energy source is also discussed.

N80-32965\*# New Mexico Univ., Albuquerque. Technology Application Center.

FORECASTS OF ENERGY TECHNOLOGY. CITATIONS FROM THE INTERNATIONAL AEROSPACE ABSTRACTS DATA BASE Progress Report, 1974 - Dec. 1979

Mary K. Gallagher Jul. 1980 60 p Supersedes NTIS/PS-79/. 0337 Sponsored in cooperation with NASA and NTIS

(NASA-CR-163596; PB80-812324; NTIS/PS-79/0337) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10A

Approximately 183 citations on the development of energy technology are presented. Emphasis is placed on forecasts relating to new energy sources such as hydrogen-based energy, solar energy conversion and to nuclear energy and coal utilization. Economic analyses of various energy conversion techniques are included.

N80-33467\*# National Aeronautics and Space Administration, Washington, D. C.

NASA TECHNOLOGY PROGRAM OVERVIEW

J. P. Mullin In NASA. Lewis Space Flight Center Synchronous Energy Technol. Sep. 1980 p 9-13

Avail: NTIS HC A07/MF A01 CSCL 21C

Various aspects of space power and electric propulsion are illustrated. The following topics are outlined: Photovoltaic power conversion; power management and distribution; chemical energy conversion and storage; thermal to electric conversion; advanced energetics; and synchronous energy technology.

N80-33468\*# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.

AIR FORCE SPACE POWER TECHNOLOGY PROGRAM

R. Barthelemy, Tom Mahefkey, and Tom Hebblewaite In NASA. Lewis Space Flight Center Synchronous Energy Technol. Sep. 1980 p 15-28

Avail: NTIS HC A07/MF A01 CSCL 10B

The military spacecraft power subsystem design requirements, developments goals, and planned technology efforts are summarized. The mission drivers of performance (weight and volume), hardening (survivability), autonomy, reliability, and miniaturization influence space mission effectiveness are outlined. The anticipated performance versus power level trends for reactor static conversion systems are illustrated. A conceptual design for a space based radar system is also given.

N80-33917# National Technical Information Service, Springfield, Va.

STATE-OF-THE-ART REVIEWS AND BIBLIOGRAPHIES ON ENERGY. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - 1978

Audrey S. Hundemann Jul. 1980 290 p (PB80-812886) Avail: NTIS HC \$30.00/MF \$30.00 CSCL

Citations to bibliographies, state-of-the-art reviews, and literature surveys on various aspects of fossil fuels, wind, solar energy, hydrogen, geothermal energy, nuclear energy, and batteries are presented. A few citations pertain to electric power. This updated bibliography contains 280 citations, none of which are new entries to the previous edition.

N80-33918# National Technical Information Service, Springfield, Va.

STATE-OF-THE-ART REVIEWS AND BIBLIOGRAPHIES ON ENERGY. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1979 - Jun. 1980

Audrey S. Hundemann Jul. 1980 117 p Supersedes NTIS/PS-79/0639; NTIS/PS-78/0586

(PB80-812894; NTIS/PS-79/0639; NTIS/PS-78/0586) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 10A

Citations to bibliographies, state-of-the-art reviews, and literature surveys on various aspects of fossil fuels, wind, solar energy, hydrogen, geothermal energy, nuclear energy, and batteries are presented. A few citations pertain to electric power. This updated bibliography contains 107 citations, 77 of which are new entries to the previous edition.

N80-33919# Applied Physics Lab., Johns Hopkins Univ., Laurel.

ENERGY PROGRAMS AT THE JOHNS HOPKINS UNIVER-SITY APPLIED PHYSICS LABORATORY Quarterly Report, Jan. - Mar. 1980

May 1980 48 p refs (Contracts EX-76-A-36-1008: DE-A101-79ET-27025)

(PB80-195316: JHU/APL/EQR/80-1) HC A03/MF A01 CSCL 10A

NTIS

Research projects dealing with the following topic areas are discussed. Geothermal energy development planning and technical assistance, operational research, hydroelectric power development, seismotectonic investigation, and energy conversion and storage techniques are among the topics covered.

N80-34299# National Technical Information Service, Springfield,

TECHNOLOGY ASSESSMENT, CITATIONS FROM THE NTIS

DATA BASE Progress Report, Aug. 1977 - 1978

Mary E. Young Jul. 1980 267 p Supersedes NTIS/PS-79/0841 and NTIS/PS-78/0831

(PB80-813165; NTIS/PS-79/0841; NTIS/PS-78/0831) Avail: NTIS HC \$30.00/MF \$30.00 CSCL 05A

The bibliography cites references concerning the assessment of technology in a wide variety of fields from social to the physical sciences. The majority of the references are in the applied physical sciences, including energy. Theoretical and applied studies are covered. This updated bibliography contains 262 citations, none of which are new entries to the previous edition.

N80-34300# National Technical Information Service, Springfield, Va.

TECHNOLOGY ASSESSMENT. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1979 - Jul. 1980

Mary E. Young Jul. 1980 155 p Supersedes NTIS/PS-79/0841 and NTIS/PS-78/0831 (PB80-813173; NTIS/PS-79/0841; NTIS/PS-78/0831) Avail:

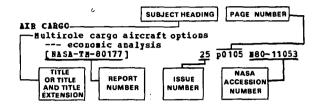
NTIS HC \$30.00/MF \$30.00 CSCL 05A

The bibliography cites references concerning the assessment of technology in a wide variety of fields from social to the physical sciences. The majority of the references are in the applied physical sciences, including energy. Theoretical and applied studies are covered. This updated bibliography contains 150 citations, 94 of which are new entries to the previous edition.

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**JANUARY 1981** 

## Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title or title and title extension provides the user with a brief description of the subject matter. The report number helps to indicate the type of document cited (e.g., NASA report, translation, NASA contractor report). The issue page and accession numbers are located beneath and to the right of the title e.g., 25 p0105 N80-11053 Under any subject heading the accession numbers are arranged in sequence with the IAA accession numbers appearing first.

Α	
ABLATION	
The feasibility of pellet re-fuel	ling of a fusion
reactor	-
	p0719 A80-44661
A model for laser driven ablative	
	p0735 A80-49069
ABSORBERS (ROUIPHENT)	
Absorption refrigeration machine	iriwen by solar
heat	-0646 200 34044
[ECB-6748-EN]	p0646 N80-31914
ABSOBBERS (MATERIALS)  Energy savings obtainable through	pagging golon
techniques	happine solar
[LA-UR-80-746]	p0632 N80-28891
Survey of selective solar absorber	
limitations	
[ SAND-79-2371C]	p0639 N80-29889
National solar optical materials	
overview	
[SERI/TP-641-619]	p0639 N80-29892
Oxidation of electrodeposited black	ck chrome
selective solar absorber films	
[SAND-80-1045C]	p0656 N80-32953
ABSORPTANCE	
Spectral effects on direct-insolar	tion absorptance
of five collector coatings	
[ASME PAPER 79-HT-18]	p0597 A80-45722
Advanced thin silicon solar cell	
optical absorptance for space	ce power systems
and arrays	-0004 200 00040
ABSORPTION COOLING	p0601 A80-46710
Solar powered absorption air cond.	itionina
Solar boseled apportion all cond-	p0629 A80-53475
Development of solar driven absorp	
conditioners and heat rumps	Pozon dir.
[LBL-10771]	p0642 N80-30925
AC GENERATORS	P0012 200 00323
A study of the applicability/compa	atibility of
inertial energy storage systems	to future space
nissions	
[ NA SA-CR-163584 ]	p0777 H80-32856
ACCELERATED LIPE TESTS	•
The Intelsat V nickel- cadmium bar	
•	p0769 A80-48395
Performance of the recently devel	oped Ni-Cd cells
for the BTS-III batteries	-0960 -00 #5555
•	p0769 A80-48399
· · · · · · · · · · · · · · · · · · ·	

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An accelerated test design for use with
      synchronous orbit --- on Ni-Cd cell degradation
                                                    p0770 A80-48401
ACTIVATED SLUDGE
    Large advanced waste treatment plants
                                                    p0569 A80-44412
    Biogasification of municipal waste
                                                    p0683 A80-49997
ADDITIVES
    The influence of grain size and dopant
      concentration on the electrical properties of polycrystalline silicon films
                                                    p0600 A80-46696
ADSORPTION
    Sorption of moisture and methane on Fruitland coal --- in underground coal conversion
         push-pull test - A method of evaluating
      formation adsorption parameters for predicting the environmental effects on in-situ coal
      gasification and uranium recovery
                                                    p0576 A80-52968
ARRODYNAMIC CHARACTERISTICS
    Wind energy capacity of a single airfoil with vertical axis on a circular track
                                                    p0673 A80-48274
    Implications of the effects of wind characteristics on the operation of large wind
                                                    p0727 A80-48321
    Wake decay and power reduction in wind farm arrays - An application to the array proposed for the
      Kahuku Bills
                                                    p0735 A80-48523
ARRODYNAMIC CONFIGURATIONS
    Composite rotor blades for large wind energy
      installations
      [NASA-TH-75822]
                                                    p0749 N80-31881
ARROHAUTICS
    NASA program plan
[NASA-TM-81136]
                                                    p0781 H80-31269
ARROSOLS
    Sulfate aerosol production and growth in coal-operated power plant plumes
                                                    p0572 A80-48533
    Summary of Solar Experience with the Soiling of
      Optical Surfaces
      [ SERI/TP-334-4781
                                                    p0639 N80-29894
    International Conference on Air pollution, volume 4 p0592 N80-33954
ARROSPACE REVIRORMENTS
    Photovoltaic generators in space

    conference

    proceedings, Heidelberg, 15-17 Apr. 1980
[ESA-SP-147] p0658 N80-
Potential use of terrestrial photovoltaics for
                                                    p0658 N80-33873
      future space solar arrays
    p0658 B80-33882
Impact of terrestrial solar cell development or
      space applications
                                                    p0659 N80-33893
ABROSPACE INDUSTRY
    Energy to the 21st century; Proceedings of the
      Fifteenth Intersociety Energy Conversion
Engineering Conference, Seattle, Wash., August
18-22, 1980. Volumes 1, 2 and 3
                                                    p0722 A80-48165
ARROSPACE SCIENCES
    NASA program plan
[NASA-TM-81136]
                                                    p0781 N80-31269
ARBOSPACE SYSTEMS
    Aerospace nickel-cadmium/mickel-hydrogen electrode
      process facility
                                                    D0769 A80-48396
```

ARCOSPACE TECHNOLOGY TEAMSPER	Some etching studies of the microstructure and
The extraterrestrial imperative. III - New	composition of large aluminosilicate particles
earth-space energy metabolism. I	in fly ash from coal-burning power plants
p0688 A80-53323	p0569 A80-45481
Aerospace technology transfer	A study of the gaseous and particulate pollutants
[SHIAS-792-422-112] p0579 N80-29210	in the environment of a thermal power plant
Example of a policy aimed at increasing the value	project area
of spin-offs from space technology in other fields	p0570 A80-46150
[SNIAS-801-422-101] p0782 N80-32297	Start-up consideration in utility use of a refuse
Impact of terrestrial solar cell development on	derived fuel
space applications	p0673 A80-48276
р0659 н80-33893	Sulfate aerosol production and growth in
AGGLOMERATION	coal-operated power plant plumes
Combustion studies of coal-in-oil droplets	p0572 A80-48533
[DOE/ET-10660/1] p0702 m80-31499	Conversion of nitrogen oxide gases to nitrate
Advanced coal gasification system for electric	particles in oil refinery plunes
power generation	p0572 A80-48534
[PE-1514-101] p0703 B80-31634	
AGRICULTURE	Pollution control improvements in coal-fired electric generating plants - What they
Synthetic fuels from municipal, industrial and	accomplish, what they cost
agricultural wastes. Citations from the	p0573 A80-49648
American Petroleum Institute data base	The advantages of using an incineration regulation
[PB80-812365] p0711 H80-32579	system to control the emission of toxic gases
Photovoltaic applications definition and	and steam generation in refuse incineration plants
photovoltaic system definition study in the	p0574 A80-49961
agricultural sector. Volume 2: Technical results	Effluent-free flue gas scrubbing process to
[SAND-79-7018/2-VOL-2] p0586 N80-32870	separate the fine dust and the noxious gases
Photovoltaic applications definition and	from waste combustion plants
photovoltaic system definition study in the	p0574 A80-49968
agricultural sector. Volume 3. Appendixes	Integrated system for solid waste disposal with
[SAND-79-7018/3] p0652 N80-32891	energy recovery and volumetric reduction by new
AILBROWS	pyrclysis furnace
Peasibility studies of spoiler and aileron control	p0682 A80-49982
systems for large horizontal-axis wind turbines	Sulfate in diesel exhaust
p0727 A80-48318	p0575 A80-50528
AIR COMDITIONING	
	An attempt at balancing the environmental effects
Heat pumps in low temperature applications	of electric power generation with the framework
using geothermal resources	of the country's economic system
p0723 A80-48184	p0575 A80-50820
Engineering prototype studies on the CaCl2-CH3OH	The CO2 problem from the viewpoint of geoecology
chemical heat pump for sclar air conditioning,	and energy economy
heating, and storage	p0575 A80-50822
p0616 A80-48289	Optimization problems of emission reduction in
The economics of aquifer storage of chilled water	large fossil-fuel combustion facilities
for air conditioning	p0576 A80-51500
p0767 A80-48337	Formation of sulfate particles in the plume of the
Twenty years of experience with well-water-source	Four Corners Power Plant
heat pumps at Battelle's Columbus Laboratories	. p0576 A80-51660
p0733 A80-48481	Application of the lime/limestone flue gas
Solar powered absorption air conditioning	desulfurization process to smelter gases
p0629 A80-53475	p0576 A80-53084
Automotive absorption air conditioner utilizing	Formation and control of fuel-nitrogen pollutants
solar and motor waste heat	
[NASA-CASE-NPO-15183] p0634 N80-29843	in catalytic combustion of coal-derived gases [PE-2762-8] p0577 N80-28557
Passive solar heating and natural cooling of an	
	The long-term effects of trace elements emitted by
earth-integrated design	energy conversion of lignite coal
[CON7-800449-1] p0638 N80-29884	[PB80-168867] p0578 N80-28958
AIR CONDITIONING EQUIPMENT	The direct use of coal. Volume 2, part A:
A packed bed dehumidifier/regenerator for solar	Working papers, appendices 1-4
air conditioning with liquid desiccants	[PB80-184518] p0697 #80-29520
p0595 A80-45312	The direct use of coal. Volume 2, part B:
Solar-powered Rankine engine assists air	Working papers, appendices 7-9
conditioning systems with electrical generating	[PB80-184526] p0697 #80-29521
capability	The direct use of coal. Volume 2, part C:
p0611 A80-47596	Working papers, appendices 10-14
Heat pipes. Citations from the NTIS data base	[PB80-184534] p0697 N80-29522
[PB80-809940] p0781 N80-28680	The coating industry: Energy savings with
Development of solar driven absorption air	volatile organic compound emission control
conditioners and heat pumps	[TID-28706] p0579 N80-29833
[LBL-10771] p0642 N80-30925	Summary of Solar Experience with the Soiling of
AIR COOLIEG	Optical Surfaces
On calculating gas turbine efficiency reduction	oferoar parraden .
under the influence of air cooling	
	[-SERI/TP-334-478] p0639 H80-29894
under the influence of air cooling p0721 180-47415	[SERI/TP-334-478] p0639 H80-29894 Possil fuels research matrix program. US Environmental Protection Agency/Department of
under the influence of air cooling p0721 A80-47415 Measurement of natural convection in air-cooled	[SERI/TF-334-478] p0639 H80-29894 Possil fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility
under the influence of air cooling p0721 A80-47415 Measurement of natural convection in air-cooled solar collectors	[SERI/TF-334-478] p0639 H80-29894 Possil fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNI/TE-7346] p0583 H80-31632
under the influence of air cooling  p0721 A80-47415  Measurement of natural convection in air-cooled  solar collectors  p0627 A80-52834	[SERI/TP-334-478] p0639 H80-29894 Fossil fuels research matrix program. US Environmental Protection Agency/Department of Energy Fossil Fuels Research Materials Facility [ORNI/TB-7346] p0583 H80-31632 Recent coal-oil mixture combustion tests at PETC
under the influence of air cooling  p0721 A80-47415  Heasurement of natural convection in air-cooled  solar collectors  p0627 A80-52834  AIR FLOB	[SERI/TF-334-478] p0639 N80-29894 Possil fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNI/TM-7346] p0583 N80-31632 Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TR-80/5] p0706 N80-31658
under the influence of air cooling p0721 A80-47415 Heasurement of natural convection in air-cooled solar collectors p0627 A80-52834 AIR PLOS Air/rock storage for solar central receiver power	[SERI/TF-334-478] p0639 H80-29894 Possil fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Haterials Facility [ORNI/TH-7346] p0583 H80-31632 Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TH-80/5] p0706 H80-31658 Determination of air pollutant emission factors
under the influence of air cooling  p0721 A80-47415  Measurement of natural convection in air-cooled solar collectors  p0627 A80-52834  AIR FLOS Air/rock storage for solar central receiver power stations	[SERI/TF-334-478] p0639 H80-29894 Possil fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNI/TE-7346] p0583 H80-31632 Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TE-80/5] p0706 H80-31658 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in
under the influence of air cooling  p0721 A80-47415  Measurement of natural convection in air-cooled solar collectors  p0627 A80-52834  AIR FLOW Air/rock storage for solar central receiver power stations  p0613 A80-48196	[SERI/TF-334-478] p0639 H80-29894 Possif fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNL/TB-7346] p0583 H80-31632 Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TR-80/5] p0706 H80-31658 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California, volume 1
under the influence of air cooling p0721 A80-47415 Heasurement of natural convection in air-cooled solar collectors p0627 A80-52834 AIR FLOB Air/rock storage for solar central receiver power stations p0613 A80-48196 AIR IETAKES	[SERI/TF-334-478] p0639 H80-29894 Possil fuels research matrix program. US Buvironmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNI/TB-7346] p0583 H80-31632 Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TE-80/5] p0706 H80-31658 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California, volume 1 [PB80-187594] p0585 H80-31982
under the influence of air cooling p0721 A80-47415 Heasurement of natural convection in air-cooled solar collectors p0627 A80-52834  AIR FLOB Air/rock storage for solar central receiver power stations p0613 A80-48196  AIR INTARES Evaluation of the Ram-Jet device, a PCV air bleed	[SERI/TP-334-478] p0639 H80-29894 Fossil fuels research matrix program. US Environmental Protection Agency/Department of Energy Fossil Fuels Research Materials Facility [ORNI/TM-7346] p0583 H80-31632 Recent coal-oil mixture combustion tests at PETC [DOE/FEXC-TR-80/5] p0706 H80-31658 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California, volume 1 [PB80-187594] p0585 H80-31982 Determination of air pollutant emission factors
under the influence of air cooling  p0721 A80-47415  Measurement of natural convection in air-cooled solar collectors  p0627 A80-52834  AIR PLOB Air/rock storage for solar central receiver power stations  p0613 A80-48196  AIR INTARES Evaluation of the Ram-Jet device, a PCV air bleed [PB80-170657]  p0582 H80-30964	[SERI/TF-334-478] p0639 N80-29894 Possif fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNL/TB-7346] p0583 N80-31632 Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TR-80/5] p0706 N80-31658 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California, volume 1 [PB80-187594] p0585 N80-31982 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in
under the influence of air cooling p0721 A80-47415 Heasurement of natural convection in air-cooled solar collectors  p0627 A80-52834  AIR PLOB Air/rock storage for solar central receiver power stations  p0613 A80-48196  AIR INTAKES Evaluation of the Ram-Jet device, a PCV air bleed [PB80-170657]  AIR POLLUTION	[SERI/TF-334-478] p0639 H80-29894 Possil fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNI/TM-7346] p0593 H80-31632 Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TE-80/5] p0706 H80-31658 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California, volume 1 [PB80-187594] p0585 H80-31982 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California. Volume 2: Appendix
under the influence of air cooling p0721 A80-47415  Beasurement of natural convection in air-cooled solar collectors p0627 A80-52834  AIR PLOB Air/rock storage for solar central receiver power stations p0613 A80-48196  AIR INTAKES Evaluation of the Ram-Jet device, a PCV air bleed [PB80-170657] p0582 B80-30964  AIR POLUTION Environmental control technology for atmospheric	[SERI/TP-334-478] Possil fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNI/TM-7346] Possil Fuels Research Materials Facility [ORNI/TM-7346] Possil Fuels Research Materials Pacility [ORNI/TM-7346] Possil Fuels Research Materials Facility PO585 M80-31632 Potermination of air pollutant emission factors for thermal tertiary oil recovery operations in California, volume 1 [PB80-187594] Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California. Volume 2: Appendix [PB80-187602] PO585 M80-31983
under the influence of air cooling p0721 A80-47415 Reasurement of natural convection in air-cooled solar collectors  p0627 A80-52834  AIR PLOB Air/rock storage for solar central receiver power stations  p0613 A80-48196  AIR INTAKES Evaluation of the Ram-Jet device, a PCV air bleed [PB80-170657]  AIR POLLUTION Environmental control technology for atmospheric carbon dioxide	[SERI/TF-334-478] p0639 N80-29894 Possif fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNL/TH-7346] p0583 N80-31632 Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TR-80/5] p0706 N80-31658 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California, volume 1 [PB80-187594] p0585 N80-31982 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California. Volume 2: Appendix [PB80-187602] p0585 N80-31983 Pollutants from synthetic fuels production: Coal
under the influence of air cooling p0721 A80-47415  Beasurement of natural convection in air-cooled solar collectors p0627 A80-52834  AIR PLOB Air/rock storage for solar central receiver power stations p0613 A80-48196  AIR INTAKES Evaluation of the Ram-Jet device, a PCV air bleed [PB80-170657] p0582 B80-30964  AIR POLUTION Environmental control technology for atmospheric	[SERI/TP-334-478] Possil fuels research matrix program. US Environmental Protection Agency/Department of Energy Possil Fuels Research Materials Facility [ORNI/TM-7346] Possil Fuels Research Materials Facility [ORNI/TM-7346] Possil Fuels Research Materials Pacility [ORNI/TM-7346] Possil Fuels Research Materials Facility PO585 M80-31632 Potermination of air pollutant emission factors for thermal tertiary oil recovery operations in California, volume 1 [PB80-187594] Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California. Volume 2: Appendix [PB80-187602] PO585 M80-31983

SUBJECT INDEX ALUMINUM ALLOYS

Constraints on carbon dioxide production from	AIRCHAPT MAINTENANCE
fossil fuel use	JT9D-7A /SP/ jet engine performance deterioration
[ORAU/IEA-80-9(M)] p0589 M80-32983	trends
International Conference on Air Pollution, volume 1 [ISBN-0-7988-16651] p0592 880-33929	p0569 A80~44230
[1588-0-7988-16651] p0592 880-33929	AIRPOIL PROFILES
Energy conservation-air pollution abatement project	Wind energy capacity of a single airfoil with
p0592 #80-33939	Vertical axis on a circular track
International Conference on Air Pollution, volume 3 [ISBB-0-7988-1665-1] p0592 N80-33543	p0673 A80-48274
Air Pollution control device configurations	Down to earth operations centralized
[PB80-193253] p0593 880-33972	ground-based power distribution systems for
Assessment of H2S control technologies for	aircraft fuel savings
geothermal power plants	p0570 A80-46681
[PR80-1937091 p0593 N80-33973	ALASKA
Stack gas reheat evaluation	The fate and effects of crude oil spilled on
[£880-196850] p0593 #80-33980	subarctic permafrost terrain in interior Alaska
AIR QUALITY	[PB80-187305] p0585 880-31984
Ravironmental implications of electric utility	
supply plans, 1978-2000	Potential for biological conversion of biomass to
[PB80-192156] p0588 N80-32963	liquid fuels
International Conference on Air Pollution, volume 1 [ISBN-0-7988-16651] p0592 N80-33929	p0675 A80-48323
	Recovery of ethanol from fermentation broths using
Collecting fly ash from low sulphur coals: An	selective sorption-desorption
Overview of Australian experience p0592.N80~33932	p0678 A80-48516
Environmental air quality control from the inside	Development of alcohol-based synthetic transportation fuels from coal-derived synthesis
looking out	dases
p0592 #80~33960	[DOB/ET-14858/T1] p0692 H80-28566
AIR SAMPLING	First report to Congress on the use of alcohol in
International Conference on Air Pollution, volume 3	notor fuels
[ISBN-0-7988-1665-1] p0592 N80-33943	[DOR/CS-0165] p0708 N80-32548
AIRBORNE EQUIPMENT	Automotive fuels from cellulose materials
Bickel-zinc batteries for aircraft and aerospace	[NZRRDC~49] p0710 N80-32571
applications	Alcohol fuels. Citations from the Engineering
p0772 A80-48483	Index data base
Hew separator materials for nickel-cadmium	[PB80-812449] p0711 N80-32581
diretare paccerter	Alcohol fuels. Citations from the Engineering
p0772 A80-48484	Index data base
AIRCRAPT DESIGN	[PB80-812456] p0711 N80-32582
Selection of the optimal design parameters of an	ALGAB
aircraft flywheel-type power supply system	Liquid fuels production from biomass corn and
p0761 A80-47391	algae
AIRCRAFT ENGINES	[COO-4388-10] p0708 N80-32545
JT9D-71 /SP/ jet engine performance deterioration trends	An algorithm for the preliminary design of
p0569 A80-44230	Stirling engine heaters
Ceramics for turbine engine applications	p0730 A80-48411
[AGARD-CP-276] p0743 N80-29342	ALKALINE BATTERIES
Some advantages of methane in an aircraft gas	Temperature limitations of alkaline battery
turbine	electrodes
[NASA-TM-81559] p0695 H80-29502	p0766 A80-48330
AIRCRAPT PUBLS	ALLOCATIONS
Comparative analysis of the basic combustion	National Aeronautics and Space Administration
characteristics of some heavy hydrocarbon fuels	Authorization Act, 1981
in application to aircraft gas turbine engines	[PUB-LAW-96-316] p0581 M80-30226
p0721 A80-47424	ALLOYS
Energy conservation in terminal airspace through	Automotive storage of hydrogen using modified
fuel consumption modeling	magnesium hydrides
[SAR PAPER 800745] p0573 A80-49695	[SAN-1167-1] p0666 N80-31650
Prospects for hydrogen aircraft	ALPHA PARTICLES
[SAR PAPER 800756] p0664 A80-49704	On fusion alpha-particle heating of plasma below
Comparison of alternate aviation fuels [SAR PAPER 800767] p0680 A80-49711	ignition p0718 A80-44429
Puture aviation fuels - The petroleum industry	ALTERNATIVES
responds to the challenge	SPS salvage and disposal alternatives
[SAE PAPER 800769] p0680 A80-49713	[NASA-CR-161548] p0641 N80-30898
Aircraft Research and Technology for Puture Fuels	ALUMIBATES '
[NASA-CP-2146] P0694 B80-29300	Testing of sintered LiA102 structures in molten
Outlook for alternative energy sources	carbonate fuel cells
aviation fuels	p0721 A80-47143
p0694 N80-29302	PLONIBOR
Current jet fuel trends	Investigation of the service life of aluminum
p0694 H80-29303	mirrors on metal substrates at high temperatures
Aviation fuels outlook	p0611 A80-47158
p0694 #80-29304	An analysis of aluminum-air battery propulsion
Effect of refining variables on the properties and	systems for passenger vehicles
composition of JP+5	p0771 A80-48471
p0694 N80-29306	Peasibility study for industrial cogeneration fuel cell application
Military jet fuel from shale oil p0694 N80-29308	[SAM-1889-T1] p0746 N80-30934
Puels research: Puel thermal stability overview	Analysis of aluminum-air battery propulsion
p0694 H80-29324	systems for passenger vehicles
Some advantages of methane in an aircraft gas	[UCRL-83824] p0778 N80-32940
turbine	
	Aluminum air battery for electric vehicle propulsion
[ BASA-TH-81559 ] p0695 B80-29502	Aluminum air battery for electric vehicle propulsion [UCBL-84443] p0779 880-32941
[BASA-TB-81559] p0695 BB0-29502 Autoignition characteristics of aircraft-type fuels	
	[UCBL-84443] p0779 H80-32941
Autoignition characteristics of aircraft-type fuels	[UCBL-84443] p0779 M80-32941

ALUMIBUM ANTIMONIDES SUBJECT INDEX

•	
ALUMINUM ARTIMONIDES Alsb as a potential photovoltaic material p0608 A80-46786	ABALTTICAL CHRHISTRY  Development and application of analytical techniques to chemistry of donor solvent
Alsb as a candidate material for photovoltaic	techniques to chemistry of donor solvent liquefaction
solar energy conversion p0608 A80-46787	[DOB/PC-20041/T1] p0712 N80-33520
ALUMINUM BOROW COMPOSITES Properties of a solar alumina-borosilicate sheet alass	Development of unique catalysts for hydrodenitrogenation of coal-derived liquids
[SERI/TP-334-565] p0641 N80-30530	anilines [FE-3297-2] p0690 N80-28545
ALUMINUM CHIORIDES A new rechargeable high voltage low temperature	ABBRALING  Effects of thermal annealing on the deep-level
molten salt cell p0764 A80-48237	defects and I-V characteristics of 200 keV proton irradiated AlGaAs-GaAs solar cells
Sodium-sulfur-aluminum chloride cells p0764.A00-48238	p0613 A80-48204 Low-cost solar array project and Proceedings of
Some chemistry in the Li/SOC12 cell p0774 A80-51688	the 15th Project Integration Meeting [NASA-CR-163568] p0650 M80-32852
ALUMIBUM GALLIUM ARSENIDES	AMBUAL VABIATIONS
Concentration and temperature performances of Gals-Gallas solar cells	Community Annual Storage Energy System p0773 A80-50910
p0603 A80-46734 Theoretical performance of multi-layer grid	ANOMALOUS TRAPERATURE ZONES  Remote sensing applied to the prospecting of
patterns for solar cells p0605 A80-46752	geothernal anomaly in Caldas Hovas County, State of Goias, Brazil
Accurate computer analysis of solar cells	[INPR-1792-RPR/164] p0712 N80-32837
including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure	ABTEBBA DESIGN Feasibility of siting SPS rectennas over the sea
p0607 A80-46782 High-efficiency AlGaAs/GaAs concentrator solar	p0623 A80-50955 Solar power satellite offshore rectenna study
cells by organometallic vapor phase epitary	[NASA-CR-161543] p0759 B80-30891
p0610 A80-46952 Investigation of high-voltage heterophotoconverters	Satellite Power Systems (SPS) concept definition study. Volume 5: Special emphasis studies
p0611 A80-47163 Satellite Power Systems (SPS) cost review	rectenna and solar power satellite design studies [NASA-CR-3322] p0651 N80-32861
[DOE/TIC-11190] p0654 N80-32928	ABTIMONY Thermoelectric properties of bisauth-antimony thin
Alternate synthesis of electrolyte matrix for	films for energy conversion
molten carbonate fuel cells p0721 A80-47135	p0729 A80-48391 ABTIREFLECTION COATINGS
ALUMINUM SILICATES Some etching studies of the microstructure and	Surface passivation of inversion layer m.i.s. solar cells
composition of large aluminosilicate particles in fly ash from coal-burning power plants	p0612 A80-48150 Survey of selective solar absorbers and their
p0569 A80-45481	limitations
AMBIENT TEMPERATURE Computer simulation of solar pond thermal behavior	[SAND-79-2371C] p0639 N80-29889 APPROPRIATIONS
p0599 A80-46567	DOE authorization, 1981, volume 2 [GPO-61-774-VOL-2] p0581 H80-30224
Continued evaluation of compact heat exchangers for OTEC evaluation	NASA authorization, 1981, volume 5 [GPO-61-213-VOL-5] p0581.880-30225
[COO-4238-14] p0750 880-31945	APPROXIMATION
AMORPHOUS MATERIALS  Low cost solar cells based on amorphous silicon	Assessment of industrial energy conservation by unit processes
electrodeposited from organic solvents : [SAN-0113-040-T7] p0637 N80-29873	[ORAU/IRA-80-4(M)] p0584 N80-31939
ABORPHOUS SERICODUCTORS Conduction in sputtered a-Si-H Schottky-barrier	Experimental and theoretical studies of thermal
solar cells	energy storage in aquifers p0766 A80-48334
p0598 A80-46475 Structure of amorphous silicon and silicon hydrides	Seasonal thermal energy storage of chilled water in aquifers
p0599 A80-46647 Optimization studies of materials in hydrogenated	p0766 A80-48335 Temperature-induced permeability alterations in
amorphous silicon solar cells p0602 A80-46717	unconsolidated and consolidated aquifer media
Evaluation of multijunction structures using	for seasonal thermal energy storage p0766 A80-48336
amorphous Si-Ge alloys for solar cells p0602 A80-46719	The economics of aquifer storage of chilled water for air conditioning
The stability of amorphous silicon Schottky-barrier solar cells	p0767 A80-48337 Seasonal thermal energy storage
p0602 A80-46722	[PNI-3322] p0778 880-32899
Amorphous silicon solar cells p0622 A80-50625	Simplified energy design economics: Principles of
Amorphous silicon solar cells p0628 A80-52863	economics applied to energy conservation and solar energy investments in buildings
AMPLIFIERS Satellite Power Systems (SPS) concept definition	[PB80-179245] p0634 N80-29534 Minimizing consumption of exhaustible energy
study. Volume 6: In-depth element investigation	resources through community planning and design.
[NASA-CR-3323] p0651 N80-32859 AWARROBES -	Development of procedures for application during public facilities procurement process. Phase 2:
Recycling of effluents and organic residues into nethane by anaerobic digestion - New perspectives	Extension
p0683 A80-49995	[BLO-2332-3] p0580 M80-29840 ARIAHB LAUMCH VEHICLE
AMALYSIS (MATHEMATICS) Optical analysis of point focus parabolic	SPOT solar array for a three axis stabilized heliosynchronous satellite in an 800 km orbit
radiation concentrators [SERI/TR-631-336] p0646 H80-31917	роб58 #80-33880
	· · · · · · · · · · · · · · · · · · ·

SÚBJECT INDRE AUTOMOBILES

ARID LATES	AUTOCLAVES
The potential of energy farming in the southeastern California desert	Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal
[PB80-195019] p0714 H80-33921 AROMATIC COMPOUBDS	dissolution in batch autoclaves
Production of light aromatics from coal hydrogenates	AUTOMATIC COSTROL
p0680 A80-49631 Methane formation during hydrogen gasification and	Design, construction, and operation of a 150 kW solar-powered irrigation facility, phase 2
gas phase pyrolysis of selected aromatics p0689 180-54034	[ALO-4159-1] p0645 N80-31903 Automatic-control system for the 17-metre Vertical
ARRAYS Simple economic evaluation and applications	Axis Wind Turbine (VAWT) [SAND-78-0984] p0750 N80-31958
experiments for photovoltaic systems for remote sites	AUTOMOBILE ENGINES Status of the Pord program to evaluate ceramics
[SAND-80-0749C] p0655 N80-32937 ARTIFICIAL SATELLITES	for stator applications in automotive gas turbine engines
Solaser power solar energy lasing in space	p0720 A80-45375
p0622 A80-50627	An automotive transmission for automotive gas turbine power plants
Some etching studies of the microstructure and	[SAE PAPER 800099] p0736 A80-49724
composition of large aluminosilicate particles in fly ash from coal-burning power plants	Gas turbines for automotive use Book p0736 A80-50351
p0569 A80-45481	Ceramics for turbine engine applications
Factors influencing the release of boron from coal ash materials	[AGARD-CP-276] p0743 M80-29342 Study of hydrogen-powered versus battery-powered
p0570 A80-45484 Removal of metals from coal ash	automobiles [ATR-79(7759)-1-VoL-1] p0665 N80-31271
P0674 A80-48295	Reduction of fuel consumption by thermodynamic
Processes to increase utilization of power solid wastes	optimization of the Otto motor: Comparative investigation of Otto diesel engines
[ISH-245] p0702 880-30929	[RUR-6711-DE] p0585 N80-32733
ASPECT HATIO Predicted effect of grid line aspect ratio on the	Methanol/ethanol/gasoline blend fuels demonstration with stratified charge engine
performance of solar cells p0625 A80-51687	vehicles [EB80-192123] p0713 N80-33606
ASSESSMENTS Environmental assessment. Energy efficiency	AUTOMOBILE PUBLS Adapting geothermal energy to produce éthanol for
standards for consumer products	automotive fuel
[DOE/CS-0168] p0589 N80-32988	p0723 A80-48183
ATLABTIC OCEAN South Atlantic OCS physical oceanography, volume 2	Efficiency of coal use, electricity for RVs versus synfuels for ICEs
monitoring ocean currents and sea states to	[SAE PAPRE 800109] p0680 A80-49727
assess effects of oil and gas activities on the	Investigation of the feasibility of methanol as an
environment [PB80-181555] P0582 N80-31026	automobile fuel p0688 180-52881
South Atlantic OCS physical oceanography, volume 3	Preparation and stability of emulsions of methanol
monitoring ocean currents and sea states to assess the environment effects of oil and gas	in automotive diesel oil [PB80-169162] p0697 N80-29526
activities	Automotive storage of hydrogen using modified
[PB80-181563] p0583 N80-31027	magnesium hydrides
ATHOSPHEBIC BOUNDARY LAYER Wake decay and power reduction in wind farm arrays	[SAN-1167-1] p0666 N80-31650 Modifications for use of methanol or
- An application to the array proposed for the	methanol-gasoline blends in automotive vehicles
Kahuku Hills	[ALO-3682-T1] p0708 M80-32552
P0735 A80-48523	Automotive fuels from cellulose materials [NZEEDC-49] p0710 N80-32571
Changes in the potential for wind energy	Potential of diesel engine, 1979 summary source
generation due to terrain modification of the houndary-layer flow	[PB80-193659] p0585 N80-32734
p0714 N80-34020	Potential of diesel engine, emission technology
ATHOSPHERIC COMPOSITION	[PB80-192685] p0586 N80-32735 Aluminum air battery for electric vehicle propulsion
Environmental control technology for atmospheric carbon dioxide	[UCRL-84443] p0779 N80-32941
p0569 A80-45300	Preparation and stability of emulsions of methanol
The CC2 problem from the viewpoint of geoecology and energy economy	in automobile diesel oil [CSIR-CENG-294] p0713 N80-33579
p0575 A80-50822	AUTOHOBILES /
ATHOSPHERIC EPPECTS	System design of The Electric Test Vehicle - One
Effect of a heated atmosphere on the emittance of black chrome solar collector pipe surfaces	/ETV-1/ [SAE PAPER 800057] p0772 A80-49718
[UCRL-83506] p0631 N80-28677	Trade-off results and preliminary designs of
ATMOSPHERIC MODELS	Near-Term Hybrid Vehicles
Study program for encapsulation materials interface for low cost silicon solar array	[SAE PAPER 800064] p0772 A80-49723 Impact of electric cars on U.S. petroleum
[NASA-CR-163583] p0651 B80-32857	consumption
ATHOSPHERIC TURBULENCE	[SAE PAPER 800108] p0773 A80-49726
Turbulence as experienced by a moving rotor of a wind turbine	'Biberonnage' makes an electric car practical with existing batteries recharging during periods
p0727 A80-48320	of non-use
Definition of gust model concept and review of	[SAE PAPER 800204] p0773 A80-49731 A method to reclaim metallic material and energy
gust models [PNL-3138] P0712 N80-33072	from automobiles
AUGER SPECTROSCOPY	p0684 A80-50024
Oxidation of electrodeposited black chrome selective solar absorber films	Alternative fuels, fuel additives and related devices for highway vehicles: B, D and D
[SAND-80-1045C] p0656 N80-32953	proposal guidelines
•	[DOB/CS-0154] p0693 N80-28571

Potential of diesel engine, 1979 summary source	BBDS (PROCESS ENGINEERING)
document	Shift conversion and methanation in coal
[PB80-193659] p0585 H80-32734	gasification: Bench-scale evaluation of a
Potential of diesel engine, emission technology	sulfur resistant catalyst
[PB80-192685] p0586 N80-32735 Potential of spark ignition engine, effect of	[FE-3240-T4] p0692 N80-28561
vehicle design variables on top speed,	Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed
performance, and fuel economy	coal gasification
[PB80-191836] p0586 N80-32736	[GPETC/RI-80/2] p0695 N80-29507
Working group on fuel consumption targets	Second phase of a coalbed methane extraction and
[NP-24333] p0591 N80-33910	utilization program
Energy: Careful conservation or regulated waste control of automobile exhaust emissions	[AESD-THE-3026] p0700 H80-30556 Underground gasification for steeply dipping coal
p0592 880-33951	beds. Bawlins test no. 1
AUXILIARY POWER SOURCES	[SAN-13108-35] p0705 N80-31653
Selection of alternative central-station	BRIGIUM
technologies for the Satellite Power System	Setting fire to the whole forest Belgian
.(SPS) comparative assessment [DOB/ER-0052] p0580 H80-29887	energy policy
Pacific Missile Test Center energy projects.	p0569 A80-44780 BRNDING
Summary of projects, contributions, and plans	Bending behavior of lapped plastic BHV cables
[AD-A086196] p0581 H80-30903	[BNL-27331] p0760 N80-32789
Performance data for a lithium-silicon/iron	BEBIEBE
disulfide, long-life, primary thermal battery	The hydropyrolysis of coal to BTX Benzene,
[SABD-79-2148C] p0746 H80-30933 Planning for electric utility solar applications:	Toluene and Xylenes p0688 A80-53174
The effects on reliability and production cost	BERUSTRIN RUENGI PRINCIPLE
estimates of the variability in demand	Energy principle with global invariants for
[SERI/TP-351-545] p0587 N80-32888	toroidal plasmas
AXIAL PLOW TURBIERS	p0717 A80-43973
The aerodynamics of contra-rotating axial flow wind power turbines	BERYLLIUM COMPOUNDS  Hydrogen storage in a beryllium substituted Tife
[CSIE-BE-1638] p0755 B80-33868	compound
AXISYMBETRIC BODIES	p0661 A80-45060
Maximum solar flux concentration achievable with	BETA PACTOR
aricon collectors	Combined n equal to 0 and n not equal to 0 HHD
p0625 A80-51679	stability analysis of axisymmetric surface
D	current model equilibria p0719 A80-44659
В	Bifurcation of sharp boundary beta=1 multipole
BACTBRIA	equilibria plasma confinement in tokamaks
Photoelectrochemical conversion using	p0736 180-49074
reaction-centre electrodes p0596 A80-45504	BIBLIOGRAPHIES
	Heat pipes. Citations from the NTIS data base
Riological solar cell	
Biological solar cell (SEEL/TP-623-656) p0639 N80-29893	[PB80-809940] p0781 N80-28680
Biological solar cell [SERI/TP-623-656] p0639 N80-29893 BALL BEAGINGS	
Biological solar cell [SERI/TP-623-656] p0639 N80-29893 BALL BRABINGS LOW-cost flywheel demonstration program	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the NIIS data base
Biological solar cell [SERI/TP-623-656] p0639 N80-29893  BALL BRABINGS LOW-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897	[PB60-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [PB60-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRARINGS LOW-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOODS	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682
Biological solar cell [SERL/TP-623-656] p0639 N80-29893  BALL BRAINGS Low-cost flywheel demonstration program [DOE/ET-26931/T1] p0778 N80-32897  BALLOUS Solar hot air balloons	[P880-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data hase [PB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data hase [PB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRARINGS LOW-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOODS	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOE/ET-26931/T1] p0778 N80-32897  BALLOUS Solar hot air balloons p0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with	[P880-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [P880-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [P880-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [P880-809973] p0781 N80-28683  Hydrogen production. Citations from the NTIS data
Biological solar cell [SERL/TP-623-656] p0639 N80-29893  BALL BRABINGS LOW-cost flywheel demonstration program [DOE/ET-26931/T1] p0778 N80-32897  BALLOUS Solar hot air balloons  p0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic	[PB80-809940] p0781 N80-28680  Heat pipes. Citations from the HIIS data hase [PB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683  Hydrogen production. Citations from the NTIS data base
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRARINGS LOW-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS Solar hot air balloons  P0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency	[ P880-809940 ] p0781 N80-28680 Heat pipes. Citations from the NIIS data base [ P880-809957 ] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [ F880-809965 ] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [ F880-809973 ] p0781 N80-28683 Bydrogen production. Citations from the NIIS data base [ F880-810476 ] p0665 N80-29519
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOE/ET-26931/T1] p0778 N80-32897  BALLOODS Solar hot air balloons p0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency p0604 A80-46740	[ P880-809940 ] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [ FB80-809957 ] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [ FB80-809965 ] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [ FB80-809973 ] p0781 N80-28683  Hydrogen production. Citations from the BIIS data base [ FB80-810476 ] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride.
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRARINGS LOW-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS Solar hot air balloons  P0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency	[ P880-809940 ] p0781 N80-28680 Heat pipes. Citations from the NIIS data base [ P880-809957 ] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [ F880-809965 ] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [ F880-809973 ] p0781 N80-28683 Bydrogen production. Citations from the NIIS data base [ F880-810476 ] p0665 N80-29519
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOODS Solar hot air balloons  P0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure	[PB80-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [FB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [FB80-809973] p0781 N80-28683  Hydrogen production. Citations from the BIIS data base [PB80-810476] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride. Citations from the BIIS data base [PB80-811094] p0665 N80-30561  Thermionic energy conversion. Citations from the
Biological solar cell [SERL/TP-623-656] p0639 880-29893  BALL BRAINGS Low-cost flywheel demonstration program [DOE/ET-26931/T1] p0778 880-32897  BALLOUS Solar hot air balloons  P0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  P0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure	[PB80-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683  Hydrogen production. Citations from the NTIS data base [PB80-810476] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride. Citations from the NTIS data base [PB80-811094] p0665 N80-30561  Thermionic energy conversion. Citations from the NTIS data base
Biological solar cell  [SEBL/TP-623-656] p0639 N80-29893  BALL BRARINGS  Low-cost flywheel demonstration program  [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS  Solar hot air balloons  P0628 A80-52841  BAND STRUCTURE OF SOLIDS  Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  P0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683 Hydrogen production. Citations from the NTIS data base [PB80-810476] p0665 N80-29519 Bydrogen storage: Hydrogen as a hydride. Citations from the NTIS data base [PB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the NTIS data base [PB80-810906] p0747 N80-30953
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOE/ET-26931/T1] p0778 N80-32897  BALLOODS Solar hot air balloons p0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure p0607 A80-46782 Amorphous silicon solar cells p0622 A80-50625	[PB80-809940] p0781 N80-28680  Heat pipes. Citations from the HIIS data base [PB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683  Hydrogen production. Citations from the NTIS data base [PB80-810476] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride. Citations from the BTIS data base [PB80-81094] p0665 N80-30561  Thermionic energy conversion. Citations from the NTIS data base [PB80-810906] p0747 N80-30953  Hadnetohydrodynamic generators in power
Biological solar cell  [SEBL/TP-623-656] p0639 N80-29893  BALL BRARINGS  Low-cost flywheel demonstration program  [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS  Solar hot air balloons  P0628 A80-52841  BAND STRUCTURE OF SOLIDS  Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  P0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells	[P880-809940] p0781 N80-28680  Heat pipes. Citations from the HIIS data base [P880-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [P880-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [F880-809973] p0781 N80-28683  Hydrogen production. Citations from the NTIS data base [P880-810476] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride. Citations from the NTIS data base [F880-811094] p0665 N80-30561  Thermionic energy conversion. Citations from the NTIS data base [P880-810906] p0747 N80-30953  Hagnetohydrodynamic generators in power generation. Citations from the HTIS data base
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOOUS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  p0607 A80-46782 Amorphous silicon solar cells p0622 A80-50625 Photoelectrochemistry with p-Si electrodes - Effects of inversion p0737 A80-50760	[P880-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [P880-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [F880-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [F880-809973] p0781 N80-28683 Hydrogen production. Citations from the HIIS data base [P880-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the HIIS data base [P880-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the NIIS data base [P880-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the HIIS data base [P880-810856] p0748 N80-30954 Wind power. Citations from the HIIS data base
Biological solar cell [SERI/TP-623-656] p0639 N80-29893  BALL BRAINGS Low-cost flywheel demonstration program [DOE/ET-26931/T1] p0778 N80-32897  BALLOUS  Solar hot air balloons  p0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  p0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells  p0622 A80-50625  Photoelectrochemistry with p-Si electrodes - Effects of inversion  p0737 A80-50760  BATTERI CHARGEES	[PB80-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683  Hydrogen production. Citations from the NTIS data base [PB80-810476] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride. Citations from the NTIS data base [PB80-811094] p0665 N80-30561  Thermionic energy conversion. Citations from the NTIS data base [PB80-810806] p0747 N80-30953  Hagnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856] p0748 N80-30954  Wind power. Citations from the NTIS data base [PB80-811433] p0748 N80-30956
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRARINGS LOW-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOURS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells Photoelectrochemistry with p-Si electrodes - Effects of inversion  BATTERY CHARGEES Wind energy for electric vehicle recharge	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the HIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683 Hydrogen production. Citations from the NTIS data base [PB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the NTIS data base [PB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the NTIS data base [PB80-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856] p0748 N80-30954 Wind power. Citations from the NTIS data base [PB80-810856] p0748 N80-30956 Wind power. Citations from the Engineering Index
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency p0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure p0607 A80-46782  Amorphous silicon solar cells Photoelectrochemistry with p-Si electrodes - Effects of inversion p0737 A80-50760  BATTERY CHARGERS Wind energy for electric vehicle recharge p0726 A80-48273	[P880-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [FB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [FB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [FB80-809973] p0781 N80-28683  Hydrogen production. Citations from the BIIS data base [FB80-810476] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride. Citations from the BIIS data base [FB80-811094] p0665 N80-30561  Thermionic energy conversion. Citations from the BIIS data base [FB80-810906] p0747 N80-30953  Magnetohydrodynamic generators in power generation. Citations from the BIIS data base [FB80-810856] p0748 N80-30954  Wind power. Citations from the BIIS data base [FB80-811433] p0748 N80-30956  Wind power. Citations from the Bigineering Index data base
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRARINGS LOW-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOURS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells Photoelectrochemistry with p-Si electrodes - Effects of inversion  BATTERY CHARGEES Wind energy for electric vehicle recharge	[PB80-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683  Hydrogen production. Citations from the NTIS data base [PB80-810476] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride. Citations from the NTIS data base [PB80-81094] p0665 N80-30561  Thermionic energy conversion. Citations from the NTIS data base [PB80-810806] p0747 N80-30953  Hagnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856] p0748 N80-30954  Nind power. Citations from the Engineering Index data base [PB80-811441] p0748 N80-30957
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency p0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure p0607 A80-46782  Amorphous silicon solar cells Photoelectrochemistry with p-Si electrodes - Effects of inversion p0737 A80-50760  BATTERY CHARGERS Wind energy for electric vehicle recharge p0726 A80-48273 Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells	[P880-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [FB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [FB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [FB80-809973] p0781 N80-28683  Hydrogen production. Citations from the BIIS data base [FB80-810476] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride. Citations from the BIIS data base [FB80-811094] p0665 N80-30561  Thermionic energy conversion. Citations from the BIIS data base [FB80-810906] p0747 N80-30953  Magnetohydrodynamic generators in power generation. Citations from the BIIS data base [FB80-810856] p0748 N80-30954  Wind power. Citations from the BIIS data base [FB80-811433] p0748 N80-30956  Wind power. Citations from the Bigineering Index data base
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOODS Solar hot air balloons  P0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  P0607 A80-46782 Amorphous silicon solar cells P0622 A80-50625 Photoelectrochemistry with p-Si electrodes - Effects of inversion  P0737 A80-50760  BATTERY CHARGERS Wind energy for electric vehicle recharge P0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells P0766 A80-48329 Linear constraints aid selection of battery charge	[PB80-809940] p0781 N80-28680  Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681  Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682  Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683  Hydrogen production. Citations from the BIIS data base [PB80-810476] p0665 N80-29519  Hydrogen storage: Hydrogen as a hydride. Citations from the BIIS data base [PB80-811094] p0665 N80-30561  Thermionic energy conversion. Citations from the MIIS data base [PB80-810906] p0747 N80-30953  Hagnetohydrodynamic generators in power generation. Citations from the HIIS data base [PB80-811433] p0748 N80-30954  Wind power. Citations from the Engineering Index data base [PB80-811441] p0748 N80-30957  Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NIIS data base
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRARINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOURS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  p0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells  p0607 A80-46782  Amorphous silicon solar cells  p0622 A80-50625  Photoelectrochemistry with p-Si electrodes - Effects of inversion  p0737 A80-50760  BATTERY CHARGERS Wind energy for electric vehicle recharge p0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells  p0766 A80-48329  Linear constraints aid selection of battery charge control parameters for orbiting spacecraft	[P880-809940] p0781 N80-28680 Heat pipes. Citations from the HIIS data base [P880-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [F880-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [F880-809973] p0781 N80-28683 Hydrogen production. Citations from the HIIS data base [F880-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the HIIS data base [F880-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the MIIS data base [F880-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the HIIS data base [F880-811433] p0748 N80-30954 Wind power. Citations from the HIIS data base [F880-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the HIIS data base [F880-811375] p0706 N80-31660
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOODS Solar hot air balloons  P0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  P0607 A80-46782 Amorphous silicon solar cells P0622 A80-50625 Photoelectrochemistry with p-Si electrodes - Effects of inversion  P0737 A80-50760  BATTERY CHARGERS Wind energy for electric vehicle recharge P0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells P0766 A80-48329 Linear constraints aid selection of battery charge	[P880-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [P880-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [F880-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [F880-809973] p0781 N80-28683 Hydrogen production. Citations from the BIIS data base [P880-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the BIIS data base [F880-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the MIIS data base [P880-810906] p0747 N80-30953 Magnetohydrodynamic generators in power generation. Citations from the NIIS data base [F880-810856] p0748 N80-30954 Wind power. Citations from the NIIS data base [F880-811033] p0748 N80-30956 Wind power. Citations from the Engineering Index data base [F880-811441] Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NIIS data base [F880-811375] p0706 N80-31660 Solar thermal heating and cooling. A bibliography
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUIS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  p0607 A80-46782 Amorphous silicon solar cells Photoelectrochemistry with p-Si electrodes - Effects of inversion  BATTERY CHARGERS Wind energy for electric vehicle recharge p0726 A80-48273 Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells  p0766 A80-48329  Linear constraints aid selection of battery charge control parameters for orbiting spacecraft power supplies	[P880-809940] p0781 N80-28680 Heat pipes. Citations from the HIIS data base [P880-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [F880-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [F880-809973] p0781 N80-28683 Hydrogen production. Citations from the HIIS data base [F880-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the HIIS data base [F880-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the MIIS data base [F880-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the HIIS data base [F880-811433] p0748 N80-30954 Wind power. Citations from the HIIS data base [F880-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the HIIS data base [F880-811375] p0706 N80-31660
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency p0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure p0607 A80-46782  Amorphous silicon solar cells Photoelectrochemistry with p-Si electrodes - Effects of inversion p0737 A80-50760  BATTERI CHARGEBS Wind energy for electric vehicle recharge p0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells p0766 A80-48329  Linear constraints aid selection of battery charge control parameters for orbiting spacecraft power supplies p0769 A80-48400  BRAEINGLESS BOTORS Development of an 8 kW wind turbine generator for	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [FB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [FB80-809973] p0781 N80-28683 Hydrogen production. Citations from the BIIS data base [PB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the BIIS data base [FB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the MIIS data base [PB80-810906] p0747 N80-30953 Magnetohydrodynamic generators in power generation. Citations from the NIIS data base [PB80-810856] p0748 N80-30954 Wind power. Citations from the BIIS data base [PB80-811433] p0748 N80-30956 Wind power. Citations from the Engineering Index data base [PB80-811441] Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NIIS data base [FB80-811375] p0706 N80-31660 Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-31963 Wind power. Citations from the NIIS data base
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOODS Solar hot air balloons  P0628 N80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells Photoelectrochemistry with p-Si electrodes - Effects of inversion  BATTERI CHARGEBS Wind energy for electric vehicle recharge P0726 N80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells  Linear constraints aid selection of tattery charge control parameters for orbiting spacecraft power supplies  P0769 N80-48400  BRARIEGLESS BOTORS Development of an 8 kW wind turbine generator for residential type application. Phase 1: Design	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the HIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [PB80-809965] p0781 N80-28683 Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683 Hydrogen production. Citations from the HIIS data base [PB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the HIIS data base [PB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the HIIS data base [PB80-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the HIIS data base [PB80-810856] p0748 N80-30954 Wind power. Citations from the Engineering Index data base [PB80-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NIIS data base [FB80-811375] p0748 N80-31660 Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-31963 Wind power. Citations from the HIIS data base [FB80-811375] p0649 N80-31963 Wind power. Citations from the HIIS data base [FB80-811375] p0761 N80-31965
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRARIEGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  p0628 A80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  p0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells  p0622 A80-46782  Amorphous silicon solar cells  p0622 A80-50625  Photoelectrochemistry with p-Si electrodes - Effects of inversion  p0737 A80-50760  BATTERY CHARGERS Wind energy for electric vehicle recharge p0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells  p0766 A80-48329  Linear constraints aid selection of fattery charge control parameters for orbiting spacecraft power supplies  p0769 A80-48400  BEABRIEGLESS BOTORS Development of an 8 kW wind turbine generator for residential type application. Phase 1: Design and analysis. Volume 1: Executive summary	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683 Hydrogen production. Citations from the NTIS data base [PB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the BTIS data base [PB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the NTIS data base [PB80-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856] p0748 N80-30954 Wind power. Citations from the NTIS data base [PB80-811433] p0748 N80-30956 Wind power. Citations from the Engineering Index data base [PB80-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NTIS data base [PB80-811375] p0706 N80-31660 Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-31965 Wind power. Citations from the NTIS data base [PB80-811458] p0649 N80-31965
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOODS Solar hot air balloons  P0628 N80-52841  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells Photoelectrochemistry with p-Si electrodes - Effects of inversion  BATTERI CHARGEBS Wind energy for electric vehicle recharge P0726 N80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells  Linear constraints aid selection of tattery charge control parameters for orbiting spacecraft power supplies  P0769 N80-48400  BRARIEGLESS BOTORS Development of an 8 kW wind turbine generator for residential type application. Phase 1: Design	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [FB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [FB80-809973] p0781 N80-28683 Hydrogen production. Citations from the BIIS data base [PB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the BIIS data base [FB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the MIIS data base [PB80-811906] p0747 N80-30953 Magnetohydrodynamic generators in power generation. Citations from the NIIS data base [FB80-811833] p0748 N80-30954 Wind power. Citations from the BIIS data base [FB80-811431] p0748 N80-30956 Wind power. Citations from the Engineering Index data base [FB80-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NIIS data base [FB80-811375] p0706 N80-31660 Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-31963 Wind power. Citations from the NIIS data base [FB80-811458] p0751 N80-31965 Technology for large space systems. A special bibliography with indexes, supplement 3
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRABINGS LOW-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells Photoelectrochemistry with p-Si electrodes - Effects of inversion  BATTERY CHARGERS Wind energy for electric vehicle recharge p0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells  Linear constraints aid selection of tattery charge control parameters for orbiting spacecraft power supplies  BEARINGLESS BOTORS Development of an 8 kW wind turbine generator for residential type application. Phase 1: Design and analysis. Volume 1: Executive summary [DOE/DP-03533/T1-VOL-1]  BEARINGS The SBIAS magnetic bearing wheel	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683 Hydrogen production. Citations from the NTIS data base [PB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the BTIS data base [PB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the NTIS data base [PB80-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856] p0748 N80-30954 Wind power. Citations from the NTIS data base [PB80-811433] p0748 N80-30956 Wind power. Citations from the Engineering Index data base [PB80-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NTIS data base [PB80-811375] p0706 N80-31660 Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-31965 Wind power. Citations from the NTIS data base [PB80-811458] p0649 N80-31965
Biological solar cell [SEBI/TP-623-656] p0639 N80-29893  BALL BRAEINGS Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency p0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure p0607 A80-46782  Amorphous silicon solar cells p0622 A80-50625 Photoelectrochemistry with p-Si electrodes - Effects of inversion p0737 A80-50760  BATTERI CHARGES Wind energy for electric vehicle recharge p0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells p0766 A80-48329  Linear constraints aid selection of battery charge control parameters for orbiting spacecraft power supplies p0769 A80-48400  BRAEINGLESS BOTORS Development of an 8 kW wind turbine generator for residential type application. Phase 1: Design and analysis. Volume 1: Executive summary [DOE/DP-03533/T1-VOL-1] p0753 N80-32957  BBARINGS The SHIAS magnetic bearing wheel [SNIAS-792-421-101] p0775 N80-28929	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the BIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [FB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [FB80-809973] p0781 N80-28683 Hydrogen production. Citations from the BIIS data base [PB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the BIIS data base [FB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the MIIS data base [PB80-810906] p0747 N80-30953 Magnetohydrodynamic generators in power generation. Citations from the NIIS data base [PB80-810856] p0748 N80-30954 Wind power. Citations from the NIIS data base [PB80-811033] p0748 N80-30956 Wind power. Citations from the Engineering Index data base [PB80-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NIIS data base [FB80-811375] p0706 N80-31660 Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-31963 Wind power. Citations from the NIIS data base [FB80-811458] p0751 N80-31965 Technology for large space systems. A special bibliography with indexes, supplement 3 [NASA-SP-7046(03)] Synthetic fuels from municipal, industrial and agricultural wastes. Citations from the
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRARIES  Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALCOURS  Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  p0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells  p0607 A80-46782  Amorphous silicon solar cells  p0622 A80-50625  Photoelectrochemistry with p-Si electrodes - Effects of inversion  p0737 A80-50760  BATTERI CHARGEBS Wind energy for electric vehicle recharge p0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells  p0766 A80-48329  Linear constraints aid selection of battery charge control parameters for orbiting spacecraft power supplies  p0769 A80-48400  BRARIEGLESS BOTORS  Development of an 8 kW wind turbine generator for residential type application. Phase 1: Design and analysis. Volume 1: Executive summary [DOE/DP-03533/T1-VOL-1] p0775 N80-28929  PASSIVE TABS-792-421-101]  PASSIVE TABSIAS nagnetic bearing wheel [SHIAS-792-421-101]  Passive radially centered magnetic suspension for	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the HIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [PB80-809965] p0781 N80-28683 Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683 Hydrogen production. Citations from the HIIS data base [PB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the HIIS data base [PB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the HIIS data base [PB80-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the HIIS data base [PB80-810856] F0748 N80-30954 Wind power. Citations from the HIIS data base [PB80-811433] p0748 N80-30954 Wind power. Citations from the Engineering Index data base [PB80-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NIIS data base [FB80-811375] p0706 N80-31660 Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-31963 Wind power. Citations from the HIIS data base [FB80-811375] p0706 N80-31965 Technology for large space systems. A special bibliography with indexes, supplement 3 [NASA-SP-7046 (03)] p0649 N80-32410 Synthetic fuels from municipal, industrial and agricultural wastes. Citations from the American Petroleum Institute data base
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRABINGS LOW-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALLOUSS Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  p0604 A80-46740 Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells  p0607 A80-46782  Amorphous silicon solar cells  p0622 A80-50625  Photoelectrochemistry with p-Si electrodes - Effects of inversion  p0737 A80-50760  BATTERY CHARGERS Wind energy for electric vehicle recharge p0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells  p0766 A80-48329  Linear constraints aid selection of tattery charge control parameters for orbiting spacecraft power supplies  p0769 A80-48400  BEABLEGLESS BOTORS Development of an 8 kW wind turbine generator for residential type application. Phase 1: Design and analysis. Volume 1: Executive summary [DOE/DP-03533/T1-VOL-1] p0775 N80-32957  BEABLEGS  The SBIAS magnetic bearing wheel [SHIAS-792-421-101] p0775 N80-28929  Passive radially centered magnetic suspension for high velocity rotors	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the HIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [FB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [FB80-809973] p0781 N80-28683 Hydrogen production. Citations from the HIIS data base [FB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the HIIS data base [FB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the HIIS data base [FB80-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the HIIS data base [FB80-811433] p0748 N80-30954 Wind power. Citations from the HIIS data base [FB80-811431] p0748 N80-30956 Wind power. Citations from the Engineering Index data base [FB80-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the HIIS data base [FB80-811375] p0706 N80-31660 Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-31965 Technology for large space systems. A special bibliography with indexes, supplement 3 [NASA-SP-7046(03)] p0649 N80-32410 Synthetic fuels from municipal, industrial and agricultural wastes. Citations from the American Petroleum Institute data base [FB80-812365] p0711 N80-32579
Biological solar cell [SEBL/TP-623-656] p0639 N80-29893  BALL BRARIES  Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897  BALCOURS  Solar hot air balloons  BAND STRUCTURE OF SOLIDS Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency  p0604 A80-46740  Accurate computer analysis of solar cells including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure  Amorphous silicon solar cells  p0607 A80-46782  Amorphous silicon solar cells  p0622 A80-50625  Photoelectrochemistry with p-Si electrodes - Effects of inversion  p0737 A80-50760  BATTERI CHARGEBS Wind energy for electric vehicle recharge p0726 A80-48273  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells  p0766 A80-48329  Linear constraints aid selection of battery charge control parameters for orbiting spacecraft power supplies  p0769 A80-48400  BRARIEGLESS BOTORS  Development of an 8 kW wind turbine generator for residential type application. Phase 1: Design and analysis. Volume 1: Executive summary [DOE/DP-03533/T1-VOL-1] p0775 N80-28929  PASSIVE TABS-792-421-101]  PASSIVE TABSIAS nagnetic bearing wheel [SHIAS-792-421-101]  Passive radially centered magnetic suspension for	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the HIIS data base [PB80-809957] p0781 N80-28681 Heat pipes. Citations from the Engineering Index data base [PB80-809965] p0781 N80-28682 Heat pipes. Citations from the engineering index data base [PB80-809965] p0781 N80-28683 Heat pipes. Citations from the engineering index data base [PB80-809973] p0781 N80-28683 Hydrogen production. Citations from the HIIS data base [PB80-810476] p0665 N80-29519 Hydrogen storage: Hydrogen as a hydride. Citations from the HIIS data base [PB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from the HIIS data base [PB80-810906] p0747 N80-30953 Hagnetohydrodynamic generators in power generation. Citations from the HIIS data base [PB80-810856] F0748 N80-30954 Wind power. Citations from the HIIS data base [PB80-811433] p0748 N80-30954 Wind power. Citations from the Engineering Index data base [PB80-811441] p0748 N80-30957 Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the NIIS data base [FB80-811375] p0706 N80-31660 Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-31963 Wind power. Citations from the HIIS data base [FB80-811375] p0706 N80-31965 Technology for large space systems. A special bibliography with indexes, supplement 3 [NASA-SP-7046 (03)] p0649 N80-32410 Synthetic fuels from municipal, industrial and agricultural wastes. Citations from the American Petroleum Institute data base

SUBJECT INDEX BIORASS ENERGY PRODUCTION

·	·
Nigobal funds Gitations from the Engineering	The production of substitute natural gas and
Alcohol fuels. Citations from the Engineering Index data base	recyclables from municipal solid waste
[PB80-812456] p0711 B80-32582	p0683 A80-49996
Porecasts of energy technology. Citations from the International Aerospace Abstracts data base	Biogasification of municipal waste p0683 A80-49997
[BASA-CR-163596] p0782 N80-32965	Bethane production from urban solid wastes
Lithium batteries. Citations from the BTIS data	p0683 A80-50000
base [PB80-812399] p0779 180-32967	Biophotolytic H2 production using alginate-immobilized chloroplasts, enzymes and
Lithium batteries. Citations from the Engineering	synthetic catalysts
Index data base	p0664 A80-50247
[PB80-812407] p0779 B80-32968  Hydrogen use as a fuel. Citations from the HTIS	Biomass for energy Book p0687 180-52851
data base	World biomass - An overview
[PB80-813090] p0667 N80-33607 State-of-the-art reviews and bibliographies on	p0687 A80-52852
energy. Citations from the HTIS data base	UK Department of Energy Solar Biological Programme - Biofuels
[PB80-812886] p0782 N80-33917	p0687 A80-52853
State-of-the-art reviews and bibliographies on energy. Citations from the NTIS data base	Wood fuel production experiments in Sweden p0687 A80-52854
[PB80-812894] p0782 880-33918	The Brazilian National Alcohol Programme
Lead batteries. Citations from the BTIS data base	p0687 A80-52855
[PB80-813363] p0780 M80-33923 Lead batteries. Citations from the Engineering	Canadian biomass perspective - A new interest in an old fuel
Index data base	p0687 A80-52856
[PB80-813371] p0780 m80-33924	Research, development, and commercialization
Technology Assessment. Citations from the NTIS data base	activities on biomass energy in the United States p0687 A80-52857
[PB80-813165] p0783 N80-34299	Biomass - Future developments
Technology Assessment. Citations from the NTIS	p0687 A80-52858
data base [PB80-813173] p0783 N80-34300	European Community's biomass programme p0687 A80-52859
BIHARY MIXTURES	The potential role of biofuels within the built
An investigation of the thermal energy storage capacity of Glauber's salt with respect to	environment
thermal cycling	p0688 A80-53474 Integrated solar receiver/biomass gasifier research
p0774 A80-51683	[SERI/TP-333-507] p0630 N80-28565
BIOCONVERSION Biomass for energy Book	The potential of energy farming for transport fuels in New Zealand
p0687 A80-52851	[PB80-154248] p0693 N80-28572
UK Department of Energy Solar Biological Programme	The potential of energy farming for transport
- Biofuels p0687 A80-52853	fuels in New Zealand, appendices [PB80-154255] p0693 N80-28573
The Brazilian National Alcohol Programme	Carbohydrate crops as a renewable resource for
p0687 A80-52855	fuels production. Volume 3: Juice preservation
Biomass - Future developments p0687 A80-52858	[BMI-2031-VOL-3] p0696 N80-29511 Biomass liquefaction efforts in the United States
Micro-level land use impacts of bioconversion	[LBL-10456] p0696 N80-29512
[LA-UR-80-1426] p0709 N80-32562	Production of sugarcane and tropical grasses as a
BIOLOGICAL EPPECTS  The direct use of coal. Volume 2, part B:	renewable energy source [080-5912-T3] p0699 N80-30543
Working papers, appendices 7-9	Research and evaluation of biomass
[PB80-184526] p0697 B80-29521 Possil fuels research matrix program. US	resources/conversion/utilization systems (market/experimental analysis for development of
Environmental Protection Agency/Department of	a data base for a fuels from biomass model)
Energy Fossil Fuels Research Materials Facility	[DOE/RT-20611/11] p0700 M80-30552
[ORNL/TM-7346] p0583 N80-31632 BIOMASS EMERGY PRODUCTION	Chemistry of lignite liquefaction [PE-2211-11] p0704 N80-31642
Conversion of carbohydrate into hydrogen fuel by a	Liquid fuels from biomass: Catalysts and reaction
photocatalytic process	conditions
p0661 180-44598 Economics of wood energy systems for industries	[LBL-9789] p0705 R80-31646 Survey of biomass gasification. Volume 3:
p0673 A80-48275	Current technology and research
Alternatives for heat supply in biomass energy conversion systems	[SERI/TR-33-239-VOL-3] p0705 N80-31648 Synthetic fuels from municipal, industrial, and
p0673 A80-48277	agricultural wastes. Citations from the NTIS
Kelp processing and biomethanation technology	data base
p0673 A80-48278 Status of peat biogasification development	[PB80-811375] p0706 N80-31660 Liquid fuels production from biomass corn and
P0674 A80-48293	algae
Electric power generation using low temperature geothermal resources and wood residues	[COO-4388-10] p0708 N80-32545 Assessment of Peruvian biofuel resources and
p0675 A80-48315	alternatives
Potential for biological conversion of biomass to	[ANL/BES/TM-86] p0708 N80-32547
liquid fuels p0675 180-48323	Micro-level land use impacts of bioconversion [LA-UR-80-1426] p0709 N80-32562
Recovery of ethanol from fermentation broths using	California's biomass and its energy potential
selective sorption-desorption	[LBL-10058] p0709 N80-32564
p0678 A80-48516 Wood waste gasification as a source of energy	Automotive fuels from cellulose materials [NZERDC-49] p0710 N80-32571
p0679 A80-49540	Biomass energy production. Citations from the
Biomass gasification processes p0682 180-49978	International Aerospace Abstracts data base [PB80-810807] p0711 N80-32576
Biogas from residues of animal husbandry and	Evaluation of processes for producing gasoline
agricultural plant production	from wood
p0683 A80-49994 Recycling of effluents and organic residues into	[DOE/PE-70048/T2] p0713 N80-33602 The potential of energy farming in the
methane by anaerobic digestion - New perspectives	southeastern California desert
p0683 A80-49995	[FB80-195019] p0714 #80-33921

BIOTECHBOLOGY	Cogeneration Technology Alternatives Study (CTAS).
Peasibility of a peat biogasification process p0669 180-46197	Volume 6: Computer data. Part 2: Residual-fired nocogeneration process boiler
Technology Assessment. Citations from the HTIS	[HASA-CR-159770-PT-2] p0745 H80-30890
data base :	Recent coal-oil mixture combustion tests at PBTC
[PB80-813165] p0783 B80-34299 Technology Assessment. Citations from the BTIS	[DOE/FETC-TR-80/5] p0706 H80-31658 Cogeneration Technology Alternatives Study (CTAS).
data base	Volume 6: Computer data. Part 2:
[PB80-813173] p0783 H80-34300 BISHOTH	Residual-fired nocogeneration process boiler [NASA-CE-159770-PT-2] p0591 B80-33861
Thermoelectric properties of bismuth-antimony thin	BONDING
films for energy conversion p0729 A80-48391	Advanced photovoltaic concentrator cells
BISHUTE COMPOUNDS	[DSE-4042-T40] p0645 B80-31904 B0R0W
Present and future status of thermochemical cycles ·	Pactors influencing the release of boron from coal
applied to fusion energy sources	ash materials p0570 A80-45484
BITUMBUS	On the effects of boron and phosphorus primary
Sorption of moisture and methane on Pruitland coal	impurities in p-type silicon material for solar cells
p0676 A80-48346	p0606 A80-46758
Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal	BOUNDARY LAYER FLOW Study of the insulating wall boundary layer in a
dissolution in batch autoclaves	Paraday MHD generator
p0679 180-49627	p0722 180-47763
Applied research and evaluation of process concepts for liquefaction and gasification of	Changes in the potential for wind energy generation due to terrain modification of the
Western coals	boundary-layer flow
[FE-2006-17] p0700 H80-30549 BLAHERTS (FUSION REACTORS)	p0714 H80-34020 BOUNDARY LAYER PLASMAS
Blanket options for high-efficiency fusion power	Bifurcation of sharp boundary beta=1 multipole
p0729 A80-48360 Interfacing the Tandem Mirror Reactor to the	equilibria plasma confinement in tokamaks p0736 180-49074
sulfur-iodine process for hydrogen production	Pseudo-shock as a qualitative model in the
p0662 180-48404	investigation of the influence of wall roughness
Materials considerations for the coupling of thermochemical hydrogen cycles to tandem mirror	on the performance of supersonic MHD generators [AD-A088333] p0754 H80-33228
reactors	BOUNDARY LAYERS
p0662 A80-48405 Scoping study of a tandem-mirror fusion reactor	Joule heating effects in the electrode wall boundary layer of MHD generators
coupled to a thermochemical hydrogen synfuel plant	p0743 N80-29620
p0662 A80-48406 Development of a falling-bed fusion blanket system	BOUNDARY VALUE PROBLEMS
for synthetic fuel production	Eigenvalue bounds for Hill's equation in stability theory for magnetohydrodynamic
-0670 100 40447	
p0678 A80-48447	equilibria
High-temperature fusion blanket for a synthetic	equilibria p0720 A80-45851
High-temperature fusion blanket for a synthetic fuel plant p0663 180-48451	p0720 A80-45851 BRATTON CICLE The solution to the gas turbine temperature problem
High-temperature fusion blanket for a synthetic fuel plant p0663 180-48451	p0720 A80-45851  BRAYTOB CICLB  The solution to the gas turbine temperature problem  engine design
High-temperature fusion blanket for a synthetic fuel plant p0663 180-48451  BOILERS Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open	p0720 A80-45851  The solution to the gas turbine temperature problem engine design  p0738 A80-50949
High-temperature fusion blanket for a synthetic fuel plant p0663 180-48451 BOILERS Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HED radiant boiler	p0720 A80-45851  BRAYTOB CICLE The solution to the gas turbine temperature problem engine design p0738 A80-50949  BRAYIL Remote sensing applied to the prospecting of
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler [ASE PAPER 80-HI-44]  Development of steam generator components for	p0720 A80-45851  The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRAXIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Braxil
High-temperature fusion blanket for a synthetic fuel plant  p0663 A60-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASME PAPER 80-HI-44]  Development of steam generator components for open-cycle MHD	p0720 A80-45851  BRATTON CICLE The solution to the gas turbine temperature problem engine design p0738 A80-50949  BRATIL Remote sensing applied to the prospecting of geothermal anomaly in Caldas Howas County, State of Goias, Brazil [IMPE-1792-BPE/164] p0712 H80-32837
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler [ASE PAPER 80-HI-44]  Development of steam generator components for	p0720 A80-45851  The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRAXIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Braxil
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASME PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD  p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems	p0720 A80-45851  BRATTOB CICLE  The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Brazil [INPE-1792-NPE/164]  P0712 N80-32837  BRINES  Power production from geothermal brine with the rotary separator turbine
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler [ASME PAPER 80-HI-44]  Development of steam generator components for open-cycle HBD  p0723 A80-48186  Economic analysis of coal burning fluidized bed	p0720 A80-45851  BRATTOB CICLE The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRAXIL Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Braxil [INPE-1792-RPE/164]  P0712 R80-32837  BRINES Power production from geothermal brine with the
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASME PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD  p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized ted toiler	p0720 A80-45851  BRATTOB CICLE  The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Bovas County, State of Goias, Brazil [IBPE-1792-RPE/164] p0712 H80-32837  BRIBES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler [ASME PAPER 80-HI-44] p0722 A80-48022  Development of steam generator components for open-cycle HBD  p0723 A80-48186  BCONOMIC analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 A80-48200	BRATTOB CICLE The solution to the gas turbine temperature problem engine design  BRAZIL Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Brazil [INPE-1792-RPE/164]  BRINES Power production from geothermal brine with the rotary separator turbine  p0725 180-48266 Generalized performance predictions for energy
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASME PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized ted toiler  p0672 180-48201  Design and operation of fluidised bed industrial boilers and hot gas producers	BRATTOB CICLE  The solution to the gas turbine temperature problem engine design  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Brazil [INPE-1792-RPE/164]  PO712 N80-32837  BRINES  Power production from geothermal brine with the rotary separator turbine  PO725 A80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluide  Alternative Gas Norkshop
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASRE PAPER 80-HI-44] p0722 A80-48022  Development of steam generator components for open-cycle MHD  P0723 A80-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 A80-48200  Circulating fluidized bed roiler  p0672 A80-48201  Design and operation of fluidised bed industrial boilers and hot gas producers	BRATTOB CICLE The solution to the gas turbine temperature problem engine design  BRAZIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Brazil [INPE-1792-RPE/164]  PO712 N80-32837  BRINES  Power production from geothermal brine with the rotary separator turbine  p0725 N80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASHE PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized ted toiler  p0672 180-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 180-48202  Economics of wood energy systems for industries p0673 180-48275	BRATTOB CICLE  The solution to the gas turbine temperature problem engine design  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Bovas County, State of Goias, Brazil [IBPE-1792-RPE/164]  BRIBES  Power production from geothermal brine with the rotary separator turbine  p0725 180-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 180-48268  Alternative Gas Workshop [LA-8155-C]  BBIQUETS  Combustible briguets from waste using the
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASME PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD  p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized bed industrial boilers and hot gas producers  p0672 180-48202  Economics of wood energy systems for industries p0673 180-48275  Start-up consideration in utility use of a refuse	BRATTON CICLE  The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Howas County, State of Goias, Brazil [IMPE-1792-RPE/164] p0712 H80-32837  BRIMES  Power production from geothermal brine with the rotary separator turbine  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268  Alternative Gas Workshop [LA-8155-C] p0690 H80-28547  BRIQUETS  Combustible briquets from waste using the FIMEDA/LOAS process
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASHE PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized ted toiler  p0672 180-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 180-48202  Economics of wood energy systems for industries p0673 180-48275  Start-up consideration in utility use of a refuse derived fuel	BRATTON CICLE  The solution to the gas turbine temperature problem engine design  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Brazil [INPE-1792-RPE/164]  PO712 H80-32837  BRIMES  Power production from geothermal brine with the rotary separator turbine  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  Alternative Gas Workshop [LA-8155-C]  BRIQUETS  Combustible briquets from waste using the PINEDA/LOAS process  P0683 A80-50009  BROTES
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASME PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD  p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized ted boiler  p0672 180-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 180-48202  Economics of wood energy systems for industries p0673 180-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 180-48276  Co-firing densified refuse derived fuel in a	BRATTON CICLE  The solution to the gas turbine temperature problem engine design  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Howas County, State of Goias, Brazil [IMPE-1792-RPR/164]  PO712 H80-32837  BRIMES  Power production from geothermal brine with the rotary separator turbine  Generalized performance predictions for energy conversion plants using geopressured geothermal fluide  Alternative Gas Workshop [LA-8155-C]  BRIQUETS  Combustible briquets from waste using the PIMEDA/LOAS process  P0683 A80-50009  BROTES  Recovery of ethanol from fermentation broths using
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASHE PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized ted toiler  p0672 180-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 180-48202  Economics of wood energy systems for industries p0673 180-48275  Start-up consideration in utility use of a refuse derived fuel	BRATTON CICLE  The solution to the gas turbine temperature problem engine design  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Brazil [INPE-1792-RPE/164]  PO712 H80-32837  BRIMES  Power production from geothermal brine with the rotary separator turbine  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  Alternative Gas Workshop [LA-8155-C]  BRIQUETS  Combustible briquets from waste using the PINEDA/LOAS process  P0683 A80-50009  BROTES
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASME PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD  BCONOMIC analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  Circulating fluidized ted toiler  p0672 180-48200  Circulating fluidized ted toiler  p0672 180-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 180-48202  Economics of wood energy systems for industries p0673 180-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 180-48276  Co-firing densified refuse derived fuel in a spreader stoker fired boiler  p0684 180-50018  Technical and economic feasibility of alternative	BRATTOB CYCLE  The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRAZIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Brazil [INPR-1792-RPR/164]  PO712 N80-32837  BRINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268  Alternative Gas Workshop (IA-8155-C)  BRIQUETS  Combustible briquets from waste using the PINEDA/LOAS process  p0683 A80-50009  BROTES  Recovery of ethanol from fermentation broths using selective sorption-desorption
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASHE PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized ted toiler  p0672 180-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 180-48202  Economics of wood energy systems for industries p0673 180-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 180-48276  Co-firing densified refuse derived fuel in a spreader stoker fired boiler	BRATTOB CICLE  The solution to the gas turbine temperature problem engine design  BRAILL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Bovas County, State of Goias, Brazil [IBPE-1792-RPE/164]  PO712 N80-32837  BRINES  Power production from geothermal brine with the rotary separator turbine  p0725 N80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 N80-48268  Alternative Gas Workshop (LA-8155-C)  BRIQUETS  Combustible briquets from waste using the PIEEDA/LOAS process  BROTES  Recovery of ethanol from fermentation broths using selective sorption-desorption  p0678 N80-48516  BUFFER STORAGE Thermal buffering of receivers for parabolic dish
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASME PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD  BCONOMIC analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized ted toiler  p0672 180-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 180-48202  ECONOMICS of wood energy systems for industries p0673 180-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 180-48276  Co-firing densified refuse derived fuel in a spreader stoker fired boiler  p0684 180-50018  Technical and economic feasibility of alternative fuel use in process heaters and small boilers [DOE/ELA-10547/01] p0693 180-28570  Steam engine analysis	BRATTOB CICLE  The solution to the gas turbine temperature problem engine design  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Brazil [INPE-1792-RPE/164]  PO712 N80-32837  BRINES  Power production from geothermal brine with the rotary separator turbine  PO725 A80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluide  Alternative Gas Norkshop [LA-8155-C]  BRIQUETS  Combustible briquets from waste using the PINEDA/LOAS process  PO683 A80-28547  BROTES  Recovery of ethanol from fermentation broths using selective sorption-desorption  PO678 A80-48516  BUPPER STORAGE  Thermal buffering of receivers for parabolic dish solar thermal power plants
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler  [ASHE PAPER 80-HI-44] p0722 A80-48022  Development of steam generator components for open-cycle HBD  p0723 A80-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 A80-48200  Circulating fluidized hed roiler  p0672 A80-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 A80-48202  Economics of wood energy systems for industries p0673 A80-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 A80-48276  Co-firing densified refuse derived fuel in a spreader stoker fired boiler  p0684 A80-50018  Technical and economic feasibility of alternative fuel use in process heaters and small boilers  [DOZ/EIA-10547/01]  Steam engine analysis  [FE-8917-2]	BRATTOB CICLE The solution to the gas turbine temperature problem engine design  BRAZIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State of Goias, Brazil [INPE-1792-RPE/164]  PO712 N80-32837  BRINES  Power production from geothermal brine with the rotary separator turbine  p0725 N80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 N80-48268  Alternative Gas Workshop (LA-8155-C)  BRIQUETS  Combustible briquets from waste using the PINEDA/LOAS process  p0683 N80-28547  BROTES  Recovery of ethanol from fermentation broths using selective sorption-desorption  p0678 N80-48516  BUFFER STORAGE  Thermal buffering of receivers for parabolic dish solar thermal power plants
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler  [ASME PAPER 80-HI-44] p0722 A80-48022  Development of steam generator components for open-cycle HBD p0723 A80-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities p0672 A80-48200  Circulating fluidized ted boiler p0672 A80-48201  Design and operation of fluidised bed industrial boilers and hot gas producers p0672 A80-48202  Economics of wood energy systems for industries p0673 A80-48275  Start-up consideration in utility use of a refuse derived fuel p0673 A80-48276  Co-firing densified refuse derived fuel in a spreader stoker fired boiler p0684 A80-50018  Technical and economic feasibility of alternative fuel use in process heaters and small boilers [D08/EIA-10547/01] p0693 B80-28570  Steam engine analysis [FE-8917-2] p0743 B80-29741  Bapporteur report: HBD electric power plants [MSA-TB-81554] p0743 B80-29862	BRATTOB CYCLE  The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRAZIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Movas County, State of Goias, Brazil [IMPE-1792-RPE/164]  PO712 N80-32837  BRIMES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268  Alternative Gas Workshop (IA-8155-C]  BRIQUETS  Combustible briquets from waste using the PINEDA/LOAS process  p0683 A80-28547  BROTHS  Recovery of ethanol from fermentation broths using selective sorption-desorption  BUFFER STORAGE  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  BUILDINGS  Energy conservation measures for commercial buildings used in life cycle cost analysis
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler  [ASHE PAPER 80-HI-44] p0722 A80-48022  Development of steam generator components for open-cycle HBD  p0723 A80-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 A80-48200  Circulating fluidized hed roiler  p0672 A80-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 A80-48201  Economics of wood energy systems for industries p0673 A80-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 A80-48275  Co-firing densified refuse derived fuel in a spreader stoker fired boiler  p0684 A80-50018  Technical and economic feasibility of alternative fuel use in process heaters and small boilers  [DOZ/EIA-10547/01]  Steam engine analysis  [FE-8917-2]  Rapporteur report: HBD electric power plants  [MASA-TH-81554]  Cogeneration Technology Alternatives Study (CTAS).	BRATTOB CYCLE  The solution to the gas turbine temperature problem engine design  BRAZIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Bovas County, State of Goias, Brazil [IBPE-1792-RPE/164]  PO712 N80-32837  BRINES  Power production from geothermal brine with the rotary separator turbine  p0725 N80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 N80-48268  Alternative Gas Workshop (LA-8155-C)  BRIQUETS  Combustible briquets from waste using the PIEEDA/LOAS process  BROTES  Recovery of ethanol from fermentation broths using selective sorption-desorption  p0678 N80-48516  BUFFER STORAGE  Thermal buffering of receivers for parabolic dish solar thermal power plants  BUILDINGS  Emergy conservation measures for commercial buildings used in life cycle cost analysis p0571 N80-48514
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler  [ASME PAPER 80-HI-44] p0722 A80-48022  Development of steam generator components for open-cycle HBD  p0723 A80-48186  BCONOMIC analysis of coal burning fluidized hed steam and by-product power generation systems for industrial facilities  p0672 A80-48200  Circulating fluidized hed boiler  p0672 A80-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 A80-48201  ECONOMICS Of wood energy systems for industries p0673 A80-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 A80-48276  Co-firing densified refuse derived fuel in a spreader stoker fired boiler  p0684 A80-50018  Technical and economic feasibility of alternative fuel use in process heaters and small boilers  [DOE/EIA-10547/01] p0693 R80-28570  Steam engine analysis  [FE-8917-2] p0743 R80-29741  Rapporteur report: HBD electric power plants  [MASA-TB-81554] p0743 R80-29662  Cogeneration Technology Alternatives Study (CTAS).  Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section A	BRATTOB CYCLE  The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRAZIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Movas County, State of Goias, Brazil [IMPE-1792-RPE/164]  POT12 N80-32837  BRIMES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268  Alternative Gas Workshop [LA-8155-C]  BRIQUETS  Combustible briquets from waste using the PINEDA/LOAS process  p0683 A80-28547  BROTHS  Recovery of ethanol from fermentation broths using selective sorption-desorption  BUFFER STORAGE  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  BUILDINGS  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Life cycle cost analysis in residential buildings and consumer appliances
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler [ASHE PAPER 80-HI-44] p0722 A80-48022  Development of steam generator components for open-cycle HBD  p0723 A80-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 A80-48200  Circulating fluidized bed foiler  p0672 A80-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 A80-48201  Economics of wood energy systems for industries p0673 A80-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 A80-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 A80-48276  Co-firing densified refuse derived fuel in a spreader stoker fired boiler  p0684 A80-50018  Technical and economic feasibility of alternative fuel use in process heaters and small boilers  [DOZ/ZIA-10547/01]  Steam engine analysis  [FE-8917-2]  Rapporteur report: HBD electric power plants  [MASA-TH-81554]  Cogeneration Technology Alternatives Study (CTAS).  Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section A [MASA-CR-159770-PT-1-A]  p0743 M80-30888	BRATTOB CYCLE  The solution to the gas turbine temperature problem engine design  BRAZIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Movas County, State of Goias, Brazil [IMPE-1792-RPE/164]  PO712 M80-32837  BRINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268  Alternative Gas Workshop (LA-8155-C)  BRIQUETS  Combustible briquets from waste using the PIMEDA/LOAS process  p0683 A80-50009  BROTES  Recovery of ethanol from fermentation broths using selective sorption-desorption  p0678 A80-48516  BUFFER STORAGE  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  BUILDINGS  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Life cycle cost analysis in residential buildings and consumer appliances
High-temperature fusion blanket for a synthetic fuel plant  p0663 A80-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle HBD radiant boiler  [ASME PAPER 80-HI-44] p0722 A80-48022  Development of steam generator components for open-cycle HBD  p0723 A80-48186  BCONOMIC analysis of coal burning fluidized hed steam and by-product power generation systems for industrial facilities  p0672 A80-48200  Circulating fluidized hed boiler  p0672 A80-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 A80-48201  ECONOMICS Of wood energy systems for industries p0673 A80-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 A80-48276  Co-firing densified refuse derived fuel in a spreader stoker fired boiler  p0684 A80-50018  Technical and economic feasibility of alternative fuel use in process heaters and small boilers  [DOE/EIA-10547/01] p0693 R80-28570  Steam engine analysis  [FE-8917-2] p0743 R80-29741  Rapporteur report: HBD electric power plants  [MASA-TB-81554] p0743 R80-29662  Cogeneration Technology Alternatives Study (CTAS).  Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section A	BRATTOB CYCLE  The solution to the gas turbine temperature problem engine design  p0738 A80-50949  BRAZIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Movas County, State of Goias, Brazil [IMPE-1792-RPE/164]  POT12 N80-32837  BRIMES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268  Alternative Gas Workshop [LA-8155-C]  BRIQUETS  Combustible briquets from waste using the PINEDA/LOAS process  p0683 A80-28547  BROTHS  Recovery of ethanol from fermentation broths using selective sorption-desorption  BUFFER STORAGE  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  BUILDINGS  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Life cycle cost analysis in residential buildings and consumer appliances
High-temperature fusion blanket for a synthetic fuel plant  p0663 180-48451  BOILERS  Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open cycle MHD radiant boiler [ASHE PAPER 80-HI-44] p0722 180-48022  Development of steam generator components for open-cycle MHD  p0723 180-48186  Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities  p0672 180-48200  Circulating fluidized ted roiler  p0672 180-48201  Design and operation of fluidised bed industrial boilers and hot gas producers  p0672 180-48201  Economics of wood energy systems for industries p0673 180-48202  Economics of wood energy systems for industries p0673 180-48275  Start-up consideration in utility use of a refuse derived fuel  p0673 180-48276  Co-firing densified refuse derived fuel in a spreader stoker fired boiler  p0684 180-50018  Technical and economic feasibility of alternative fuel use in process heaters and small boilers [D0F/EIA-10547/01] p0693 180-28570  Steam engine analysis [FE-8917-2] p0743 180-29741  Rapporteur report: MHD electric power plants [MASA-TH-81554] p0743 180-29662  Cogeneration Technology Alternatives Study (CTAS).  Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section 1 [NASA-CR-159770-PT-1-A] p0745 180-3088  Cogeneration Technology Alternatives Study (CTAS).	BRATTON CICLE  The solution to the gas turbine temperature problem engine design  BRATIL  Remote sensing applied to the prospecting of geothermal anomaly in Caldas Bovas County, State of Goias, Brazil [IBPE-1792-RPE/164]  BRIBES  Power production from geothermal brine with the rotary separator turbine  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  Alternative Gas Workshop [LA-8155-C]  BRIQUETS  Combustible briquets from waste using the FIBEDA/LOAS process  BROTES  Recovery of ethanol from fermentation broths using selective sorption-desorption  BUFFER STORAGE  Thermal buffering of receivers for parabolic dish solar thermal power plants  BULLDINGS  Energy conservation measures for commercial buildings used in life cycle cost analysis and consumer appliances  P0572 A80-48515

BOURIEG MAIS	CALGRIBETERS
LLL in situ coal gasification project	An emissometer with high accuracy for
[UCBL-50026-79-4] p0705 H80-31654	determination of the total hemispherical
BYPASSES	emittance of surfaces of solar energy
Evaluation of the Ram-Jet device, a PCV air bleed	absorbers
[PB80-170657] p0582 H80-30964	p0621 180-4894
^	CANCER  Brongs and technology region
. •	Energy and technology review [UCRL-52000-80-6] p0588 880-3290
CABLES	[UCRL-52000-80-6] p0588 B80-32909
Bending behavior of lapped plastic BBV cables	EBIC and capacitance measurements on Cu25-Cd5
[BHL-27331] p0760 N80-32789	solar cells - Stability problems Electron
CADMICH	Beam Induced Current
Hydrogen production from the solar based LASL	p0603 A80-4672
cadmium cycle	CARBOHIDRATES
p0662 A80-48416	Conversion of carbohydrate into hydrogen fuel by a
CADMION SELEVIDES	photocatalytic process
Solar energy conversion using CdSe	p0661 A80-4459
photoelectrochemical cells with low cost	Carbohydrate crops as a renewable resource for
substrates	fuels production. Volume 3: Juice preservation
p0597 A80-46253	[BMI-2031-VOL-3] p0696 H80-2951
Progress in the development of the thin film BIS	CARBON DIOXIDE
solar cell based on CdSe	Semiconductor-electrolyte solar cells for the
p0603 A80-46728	photoelectrochemical reduction of carbon dioxide
Development of a cadmium selenide thin film solar	to organic fuel
cell	p0605 A80-4675
[BMFT-FB-T-79-72] p0640 N80-29907	Photoreduction of carbon dioxide and water into
CADMION SOLFIDES	formaldehyde and methanol on semiconductor
The spectral response of CdS:Cu/x/S solar cells	materials
formed by dry barrier techniques	p0621 A80-4892
p0597 A80-46251	Environmental control technology for carbon dioxide
Optimal material properties for CdS/Cu2S solar cells	FDOR/RV-0079 1 p0588 N80-3297:
p0603 A80-46726	CARBON DIOXIDE CONCENTRATION
Thin file /CdZn/S for solar cells	Environmental control technology for atmospheric
p0603 A80-46727	carbon dioxide
An S.E.M. study of thin films made by spray	p0569 A80-4530
pyrolysis CdS deposition on solar	The CO2 problem from the viewpoint of geoecology
photovoltaic panels	and energy economy
p0603 A80-46729	p0575 A80-5082
Model for the photovoltaic effect in Cu2S-CdS	Constraints on carbon dioxide production from
solar cells in the backwall configuration	fossil fuel use
p0607 A80-46775	[ORAU/IEA-80-9(H)] p0589 N80-3298
I-V relationship for the Cu2S/CdS solar cell	CARBON PIBERS
p0609 A80-46937	Composite rotor blades for large wind energy
Theoretical investigations into collection	installations
coefficient for Cu/2-x/S-CdS cells with	[NASA-TH-75822] p0749 N80-3188
allowance for surface states at interface	CARBON MONOXIDE
p0610 A80-47151	High-temperature fusion blanket for a synthetic
Optimized grid patterns for Cu2S-CdS solar cells	fuel plant
p0621 A80-49322	p0663 A80-4845
n-CdS/p-Si heterojunction solar cells	Soot reduction in diesel engines by catalytic
p0626 A80-52498	effects
CADMIUM TRILUBIDES	[BHL-27792] p0585 H80-3273
CdTe homojunctions solar cells	Effects of gasohol on idle HC and CO emissions
p0603 A80-46731	[FB80-190655] p0590 N80-3301
Oxide/semiconductor photovoltaic heterojunctions	CARBON STEELS
based on CdTe or InP	Internally insulated thermal storage system
p0603 A80-46732	development program
Controlled cadmium telluride thin films for solar	[SAND-80-8175] p0775 H80-2892
cell applications (emerging materials systems	CARBOHATES
for solar cell applications)	Alternate fabrication process for molten carbonate
[DOB/BT-23023/T3] p0642 H80-30921	fuel cell electrolyte structures
CALCIUM	p0721 A80-4713
Calcium/iron disulfide secondary cells	Testing of sintered Lillo2 structures in molten
p0764 A80-48239	carbonate fuel cells
CALCIUM SILICATES	p0721 A80-4714
An engineering study on the use of regenerative	Development of molten carbonate fuel cells for
calcium silicates sorbent for APB power	power generation
generation from high sulfur coal Atmospheric	p0726 A80-4827
Pluidized Bed	Industrial energy conservation with the natural
p0672 A80-48171	gas-fueled molten carbonate fuel cell
CALIFORNIA	p0571 A80-4828
Determination of air pollutant emission factors	The kinetics of the O2/CO2 reaction in molten
for thermal tertiary oil recovery operations in	carbonate - Reaction orders for 02 and CO2 on NiO
California, volume 1	in fuel cells
[PB80-187594] p0585 #80-31982	p0726 A80-4828
Determination of air pollutant emission factors	Fuel cell research on second-generation
for thermal tertiary oil recovery operations in	nolten-carbonate systems
California. Volume 2: Appendix	[SAN-11276-2] p0750 N80-3193
[PB80-187602] p0585 880-31983	Development of molten carbonate fuel cell power
California's biomass and its energy potential	plant technology
[LBL-10058] p0709 #80-32564	[DOB/ET-15440/1] p0750 H80-3193
The potential of energy farming in the	CARRIBE DENSITY (SOLID STATE)
southeastern California desert	Optimal material properties for CdS/Cu2S solar cell
[PB80-195019] p0714 B80-33921	p0603 A80-4672

CASE HISTORIES SUBJECT INDEX

CASE BISTORIES	Catalytic hydrogenation of Liddell bituminous coal
Application of battery reconditioning techniques to achieve capacity restoration - A case history	<ul> <li>Effects of process variables on coal dissolution in batch autoclaves</li> </ul>
Bi-Cd cell performance improvement for	p0679 A80-49627
spacecraft applications	Selectivity improvement in the solvent refined
p0769 A80-48397 Capital formation for small wind energy conversion	coal process. I - Detailed first-stage reaction
system manufacturers: A quide to methods and	studies - Coal mineral catalysis. II - Detailed second-stage reaction studies - Hydrotreating of
sources	coal liquids
[SBRI/TR-98298-1] p0751 N80-32462	p0679 A80-49630
CASSEGRAIN OPTICS Cassegrain solar concentrators for photovoltaics	CATRODES  Cathode sheaths in potassium seeded MHD combustion
p0608 180-46791	plasmas
CASTIEG	p0720 A80-46158
Investigation of the impurity tolerance of	Oxygen electrodes for energy conversion and storage
semicrystalline silicon solar cells silicon impact program	[DOE/ET-25502/1] p0753 B80-32878
[DOB/CH-00178/T2] p0654 H80-32934	Development of new catalysts for coal liquid
CATALYSIS	refining
Conversion of carbohydrate into hydrogen fuel by a photocatalytic process	[FE-2595-5] p0710 H80-32569 CELL ANODES
p0661 A80-44598	Models for the photoelectrolytic decomposition of
Semiconductor-electrolyte solar cells for the	water at semiconducting oxide anodes
photoelectrochemical reduction of carbon dioxide	p0664 A80-50512
to organic fuel p0605 A80-46755	Nickel hydrogen cell development centered on positive electrodes with high capacity per unit
Applied research and evaluation of process	area for load leveling and traction applications
concepts for liquefaction and gasification of	[BMPT-PB-T-79-74] p0776 N80-29908
western coals [FE-2006-16] p0691 N80-28558	CELL CATHODES Sodium-sulfur-aluminum chloride cells
Baterials for fuel cells	p0764 A80-48238
[PB80-182355] p0748 M80-30955	Establishment of parameters for production of long
CATALYSTS Disposable catalysts in the solvent refined coal	life nickel oxide electrodes for nickel-hydrogen cells
processes	p0771 A80-48445
p0676 180-48381	CELLULOSB
The influence of contact pressure on the performance of supported gas diffusion	Automotive fuels from cellulose materials [NZERDC-49] p0710 N80-32571
electrodes in alkaline H2-02-fuel cells	CEMBETS
p0739 180-51459	Energy savings in a rotary kiln in the production
Development of unique catalysts for hydrodenitrogenation of coal-derived liquids	of cement through the addition of domestic waste and sewage sludge
[FB-3297-1] p0690 N80-28482	p0574 A80-49958
Development of unique catalysts for	CERAMIC COATINGS
hydrodenitrogenation of coal-derived liquids anilines	Combustion performance of CVD silicon carbide thermionic diodes Chemical Vapor Deposition
anilines [FE-3297-2] p0690 M80-28545	thermionic diodes Chemical Vapor Deposition p0732 A80-48473
anilines [FE-3297-2] p0690 N80-28545 Development of unique catalysts for	thermionic diodes Chemical Vapor Deposition p0732 A80-48473 CERANICS
anilines [FE-3297-2] p0690 M80-28545	thermionic diodes Chemical Vapor Deposition p0732 A80-48473 CERAMICS Status of the Ford program to evaluate ceramics
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [FE-3297-3]  p0690 B80-28546	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines
anilines [PE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [PE-3297-3]  Development of new catalysts for coal liquids	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS Status of the Pord program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [FE-3297-3]  p0690 B80-28546	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466
anilines [PR-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [PR-3297-3]  Development of new catalysts for coal liquids refining [PR-2595]  Catalysts for upgrading coal-derived liquids	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [FB-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  p0691 N80-28556	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [AGARD-CP-276] p0743 #80-29342
anilines [PE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [PE-3297-3]  Development of new catalysts for coal liquids refining [PE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications
anilines [PE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [PE-3297-3]  Development of new catalysts for coal liquids refining [PE-2595]  Catalysts for upgrading coal-derived liquids [DOB/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOB/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  p0692 N80-28551	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications  [AGARD-CP-276]  Requirements for materials for land vehicle gas turbines  p0743 N80-29345
anilines [PE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [PE-3297-3]  Development of new catalysts for coal liquids refining [PE-2595]  Catalysts for upgrading coal-derived liquids [DOB/BT-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [PE-3240-14]  Catalyst development for coal liquefaction [EPEI-AP-1233]  p0696 880-29508	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERNATICS  Status of the Pord program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [MASA-CR-159886] p0698 B80-30535
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EFRI-AF-1233]  Shift conversion and methanation in coal	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 B80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 B80-30535  CHARBEL FLOR
anilines [PE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [PE-3297-3]  Development of new catalysts for coal liquids refining [PE-2595]  Catalysts for upgrading coal-derived liquids [DOE/BT-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [PE-3240-14]  Catalyst development for coal liquefaction [EPRI-AP-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [PE-3240-14]  Catalyst development for coal liquefaction [EPRI-AP-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERNATICS  Status of the Pord program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [MASA-CR-159886] p0698 B80-30535
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EPRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EPRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-75]  p0696 B80-29509	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERMBICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications  [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels  [NASA-CR-15986] p0698 B80-30535  CHANNEL PLON  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors
anilines [PE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [PE-3297-3]  Development of new catalysts for coal liquids refining [PE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [PE-3240-14]  Catalyst development for coal liquefaction [EPEI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [PE-3240-14]  Catalyst development for coal liquefaction [EPEI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [PE-3240-15]  Alloy catalysts with monolith supports for	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [A6ARD-CP-276] p0743 R80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 R80-30535  CHANNEL FLOB  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and guinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EPRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EPRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-75]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-2725-8]	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications  [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels  [NASA-CR-159886] p0698 B80-30535  CEMBEL FLOW  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Open-cycle MBD generator channel development p0723 A80-48185
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-14]  Catalyst development for coal liquefaction [EFRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-14]  Catalyst development for coal liquefaction [EFRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-T5]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-2725-8]  Investigation of sulfur-tolerant catalysts for	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [A6ARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 E80-30535  CHANNEL PLOB Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Open-cycle EBD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in
anilines [PF-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [PF-3297-3]  Development of new catalysts for coal liquids refining [PF-2595]  Catalysts for upgrading coal-derived liquids [DOE/RT-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FB-3240-T4]  Catalyst development for coal liquefaction [EPRI-AP-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FF-3240-T4]  Catalyst development for coal liquefaction [EPRI-AP-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FF-3240-T5]  Aloy catalysts with monolith supports for methanation of coal-derived gases [FE-2725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 B80-30535  CHANNEL FLOW  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Open-cycle MBD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-14]  Catalyst development for coal liquefaction [EFRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-14]  Catalyst development for coal liquefaction [EFRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-15]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases [FE-14809-1]	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [A6ARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 E80-30535  CHANNEL FLON  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Open-cycle HBD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  p0735 A80-49068  End effects in a HHD channel with diverging
anilines [PE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [PE-3297-3]  Development of new catalysts for coal liquids refining [PE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-T4]  Catalyst development for coal liquefaction [EPEI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-T4]  Catalyst development for coal liquefaction [EPEI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-T5]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases [FE-14809-1]  Bultiphase reactor modeling for zinc chloride	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [A6ARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 B80-30535  CHANNEL PLOB  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Open-cycle MHD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  p0735 A80-49068  End effects in a HHD channel with diverging electrode walls
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-14]  Catalyst development for coal liquefaction [EFRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-14]  Catalyst development for coal liquefaction [EFRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-15]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases. [FE-14809-1]  Bultiphase reactor modeling for zinc chloride catalyzed coal liquefaction [LBL-9870]  p0703 880-31528	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [A6ARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 E80-30535  CHARMEL PLOB  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Open-cycle HBD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  p0735 A80-49068  End effects in a HHD channel with diverging electrode walls  p0738 A80-50948
anilines [PE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [PE-3297-3]  Development of new catalysts for coal liquids refining [PE-5295]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [PE-3240-74]  Catalyst development for coal liquefaction [EPRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  P0692 N80-28561  Catalyst development for coal liquefaction [EPRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-T5]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-7275-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases [FE-14809-1]  Multiphase reactor modeling for zinc chloride catalyzed coal liquefaction [LBL-9870]  Liquid fuels from biomass: Catalysts and reaction	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [A6ARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 B80-30535  CHANNEL PLOB  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Open-cycle MHD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  P0735 A80-49068  End effects in a MHD channel with diverging electrode walls  P0738 A80-50948  End zone of a frame-type channel with an inhomogeneous flow current and potential
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EPRI-AP-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EPRI-AP-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-75]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases. [FE-14809-1]  Pultiphase reactor modeling for zinc chloride catalyzed coal liquefaction [LBL-9870]  Liquid fuels from biomass: Catalysts and reaction conditions	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERMBICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  p0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  p0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 B80-30535  CEMBEL FLOB  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Open-cycle MBD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  p0735 A80-49068  End effects in a MBD channel with diverging electrode walls  p0738 A80-50948  End zone of a frame-type channel with an inhomogeneous flow current and potential fields in plasma
anilines [PF-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decabydroquinoline and quinoline [PF-3297-3]  Development of new catalysts for coal liquids refining [PE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-T4]  Catalyst development for coal liquefaction [EPEL-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-T4]  P0692 N80-28561  Catalyst development for coal liquefaction [EPEL-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-T5]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases [FE-14809-1]  Multiphase reactor modeling for zinc chloride catalyzed coal liquefaction [LBL-9870]  Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789]  Bethanol and methyl fuel catalyst	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  P0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [A6ARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  P0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 N80-30535  CHANNEL PLON  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  P0598 A80-46349  Open-cycle MHD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  End effects in a MHD channel with diverging electrode walls  P0735 A80-49068  End zone of a frame-type channel with an inhomogeneous flow current and potential fields in plasma  P0739 A80-52555  Transfer function of a sensible-heat storage
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and guinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EFEI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-75]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases. [FE-14809-1]  Multiphase reactor modeling for zinc chloride catalyzed coal liquefaction [LBL-9870]  Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789]  Methanol and methyl fuel catalyst [FE-3177-5]  P0708 880-32472	CERMBICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  PO720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications  [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  PO743 B80-29345  CETABE  Autoignition characteristics of aircraft-type fuels  [NASA-CR-159886] p0698 B80-30535  CEMBEL FLOW  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  PO598 A80-46349  Open-cycle MBD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  PO735 A80-49068  End effects in a MHD channel with diverging electrode walls  PO738 A80-50948  End zone of a frame-type channel with an inhomogeneous flow current and potential fields in plasma  PO739 A80-52555  Transfer function of a sensible-heat storage element in periodic regime
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and quinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EFEI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-75]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-2729-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases. [FE-14809-1] Bultiphase reactor modeling for zinc chloride catalyzed coal liquefaction [LBL-9870]  Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9870] Bethanol and methyl fuel catalyst [FE-3177-5]  Catalyst characterization in coal liquefaction [SABD-80-0123]  P0709 880-32560	thermionic diodes Chemical Vapor Deposition p0732 A80-48473  CERAMICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  P0720 A80-45375  Ceramic dome receiver technology developments p0619 A80-48466  Ceramics for turbine engine applications [A6ARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  P0743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 N80-30535  CHANNEL PLON  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  P0598 A80-46349  Open-cycle MHD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  End effects in a MHD channel with diverging electrode walls  P0735 A80-49068  End zone of a frame-type channel with an inhomogeneous flow current and potential fields in plasma  P0739 A80-52555  Transfer function of a sensible-heat storage
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and guinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EFRI-AP-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-75]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases. [FE-14809-1]  Multiphase reactor modeling for zinc chloride catalyzed coal liquefaction [LBL-9870]  Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789]  Development of new catalysts for coal liquefaction [SABD-80-0123]  Development of new catalysts for coal liquid	CERMBICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  PO720 A80-45375  Ceramic dome receiver technology developments po619 A80-48466  Ceramics for turbine engine applications [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  PO743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 B80-30535  CEMBEL FLOB  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  PO598 A80-46349  Open-cycle MBD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  PO735 A80-49068  End effects in a HBD channel with diverging electrode walls  PO738 A80-50948  End zone of a frame-type channel with an inhomogeneous flow current and potential fields in plasma  PO739 A80-52555  Transfer function of a sensible-heat storage element in periodic regime  PO774 A80-52974  Characterization of open-cycle, coal-fired MBD generators
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and guinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EFRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [SFRI-AF-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-75]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases.  [FB-14809-1]  Bultiphase reactor modeling for zinc chloride catalyzed coal liquefaction [LBL-9870]  Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789]  Bethanol and methyl fuel catalyst [FE-3177-5]  Catalyst characterization in coal liquefaction [SABD-80-0123]  Development of new catalysts for coal liquid refining	CERABICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  PO720 A80-45375  Ceramic dome receiver technology developments po619 A80-48466  Ceramics for turbine engine applications [A6ARD-CP-276] p0743 880-29342  Requirements for materials for land vehicle gas turbines  PO743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [MASA-CR-159886] p0698 880-30535  CHAMBEL FLOB  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  PO598 A80-46349  Open-cycle MBD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  PO735 A80-49068  End effects in a MBD channel with diverging electrode walls  PO738 A80-50948  End zone of a frame-type channel with an inhomogeneous flow current and potential fields in plasma  PO739 A80-52555  Transfer function of a sensible-heat storage element in periodic regime  PO774 A80-52974  Characterization of open-cycle, coal-fired MBD generators [ABI-BP-46]
anilines [FE-3297-2]  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids decahydroquinoline and guinoline [FE-3297-3]  Development of new catalysts for coal liquids refining [FE-2595]  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-74]  Catalyst development for coal liquefaction [EFRI-AP-1233]  Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-75]  Alloy catalysts with monolith supports for methanation of coal-derived gases [FE-725-8]  Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases. [FE-14809-1]  Multiphase reactor modeling for zinc chloride catalyzed coal liquefaction [LBL-9870]  Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789]  Development of new catalysts for coal liquefaction [SABD-80-0123]  Development of new catalysts for coal liquid	CERMBICS  Status of the Ford program to evaluate ceramics for stator applications in automotive gas turbine engines  PO720 A80-45375  Ceramic dome receiver technology developments po619 A80-48466  Ceramics for turbine engine applications [AGARD-CP-276] p0743 B80-29342  Requirements for materials for land vehicle gas turbines  PO743 N80-29345  CETABE  Autoignition characteristics of aircraft-type fuels [NASA-CR-159886] p0698 B80-30535  CEMBEL FLOB  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  PO598 A80-46349  Open-cycle MBD generator channel development p0723 A80-48185  Relativistic-electron-beam/target interaction in plasma channels  PO735 A80-49068  End effects in a HBD channel with diverging electrode walls  PO738 A80-50948  End zone of a frame-type channel with an inhomogeneous flow current and potential fields in plasma  PO739 A80-52555  Transfer function of a sensible-heat storage element in periodic regime  PO774 A80-52974  Characterization of open-cycle, coal-fired MBD generators

SUBJECT INDEX CLEAR EMERG

CHARGE EXCHANGE	CHRHICAL REACTIONS
Experimental evidence of charge-exchange	Reaction modelling and correlation for flash
recombination of highly ionized iron and	hydropyrolysis of lignite
titanium in Princeton large torus p0735 A80-48765	p0678 A80-48433 Chemical and physical stability of refractories
CHARGING P0733 R80-48763	for use in coal gasification
'Biberonnage' makes an electric car practical with	[COO-2904-15] p0690 N80-28478
existing batteries recharging during periods	Coal processing for fuel cell utilization. Task
of non-use [SAE PAPER 800204] p0773 A80-49731	11: Pluidized bed coal gasification model; data analysis and predictions
CHEMICAL ANALYSIS	[ METC-8450-T1] p0701 N80-30909
Average chemical structure of mild hydrogenolysis	An improved synthesis of 2,4,8,10-tetroxaspiro
products of coals	(5.5) undecane
p0679 A80-49628 Automated multi-sample gas chromatographic	[NASA-CASE-ARC-11243-2] p0583 N80-31472 Chemistry of lignite liquefaction
analysis of fossil fuel gases	[PE-2211-11] p0704 880-31642
[MLH-2721] p0702 H80-31506	CdSiAs2 thin films for solar cell applications
Metallurgical analysis and high temperature	[DOE/ET-23007/1] p0653 N80-32919
degradation of the black chrome selective absorber [LBL-10293] p0643 N80-31538	CHEMICAL BEACTORS The CS/B advanced SHG hydrogasification process
Aviation turbine fuels, 1979	p0674 A80-48292
[DOB/BETC-PPS-80/2] p0703 N80-31627	Qualitative and quantitative assessment of
Possil fuels research matrix program. US	reaction models of coal hydrogenation
Environmental Protection Agency/Department of Energy Possil Puels Research Materials Pacility	p0679 A80-49629 Global model of countercurrent coal gasifiers
[ORNL/TH-7346] p0583 N80-31632	p0686 A80-51571
Development and application of analytical	A study on utilizing solar energy for hydrogen
techniques to chemistry of donor solvent	production
liquefaction [DOB/PC-20041/T1] p0712 N80-33520	p0665 A80-53569 Liquid-phase methanol
CHEMICAL BUERGY	[EPRI-AF-1291] p0692 N80-28567
Man-made molecular assemblies for energy	Research and evaluation of biomass
conversion from light into chemical potentials	resources/conversion/utilization systems
p0661 A80-46271 Chemical Energy Storage for Solar Thermal Electric	<pre>(market/experimental analysis for development of a data base for a fuels from biomass model)</pre>
Conversion	[DOE/ET-20611/11] p0700 H80-30552
p0763 A80-48195	Advanced development of a short-residence-time
Sensitivity analysis of the value of a solar	hydrogasifier [FE-3125-12] p0704 M80-31638
driven chemical heat pump system p0616 A80-48287	Advanced development of a short-residence-time
Development status and utility of the sulfuric	hydrogasifier
acid chemical heat pump/chemical energy storage	[FE-3125-18] p0704 N80-31639
system . p0765 A80-48288	Design, engineering and evaluation of refractory
Engineering prototype studies on the CaCl2-CH3OH	liners for slagging gasifiers [IITRI-M6043-5] p0704 M80-31640
chemical heat pump for solar air conditioning,	Materials for coal conversion and use. Volume 2:
heating, and storage	Materials of construction for coal conversion
p0616 A80-48289 Simultaneous photoproduction of hydrogen and	systems. Part 1: Coal gasification. Part 2: Coal liquefaction
oxygen by photosynthesis to convert solar	[FE-2468-59-VOL-2-PT-1/2] p0705 N80-31644
energy into stored chemical free energy	CHLORIDES
[CONF-791072-32] p0665 N80-30550	The lithium-sulfuryl chloride battery - Discharge
Sulfuric acid and water chemical heat pump/chemical energy storage program, phase 2-A	behaviour p0772 180-48770
[SAND-78-8176] p0776 N80-30924	CHLOROPLASTS
Chemical energy storage for solar thermal conversion	Biophotolytic H2 production using
[SAND-79-8198] p0652 N80-32889	alginate-immobilized chloroplasts, enzymes and
Solar gasification of charcoal, wood and paper [UCRL-84411] p0654 880-32926	synthetic catalysts
CHEMICAL ENGINEERING	CHROMIUM
Low cost processes for silicon fabricated for	Metallurgical analysis and high temperature
solar cells	degradation of the black chrome selective absorber
p0606 A80-46757 The HYGAS process to produce pipeline gas from coal	[LBL-10293] p0643 N80-31538 Improving the efficiency of silicon solar cells
p0674 A80-48291	containing chromium
The CS/R advanced SNG hydrogasification process	[NASA-CASE-NPO-15179-1] p0650 N80-32850
p0674 A80-48292 Advanced process development in coal liquefaction	Oxidation of electrodeposited black chrome , selective solar absorber films
p0676 A80-48379	[SAND-80-1045C] p0656 N80-32953
Advanced coal liquefaction processes emphasize low	CIRCUIT PROTECTION
hydrogen consumption	Development of a bipolar Zn/Br2 battery
p0676 A80-48380 Chem Systems' liquid phase methanol process	p0767 A80-48369
p0677 A80-48383	Wind energy capacity of a single airfoil with
Mobil methanol-to-gasoline process	vertical axis on a circular track
p0677 A80-48384	p0673 A80-48274
Pilot study to select candidates for energy.  Conservation research for the chemical industry	CIRCUMSOLAR RADIATION  Effect of circumsolar radiation on performance of
[DOE/TIC-11114] p0584 N80-31940	focusing collectors
Hydroprocessing of light pyrolysis fuel oil for	[SERI/TB-34-093] p0646 N80-31916
kerosene type jet fuel [AD-A089101] p0713 N80-33599	Spectral character of solar and circumsolar radiation for application to concentrating
[AD-A089101] p0713 H80-33599 CHEMICAL BRACTION CONTROL	radiation for application to concentrating solar energy systems
Behavior of secondary lithium and aluminum-lithium	[LBL-10802] p0653 N80-32916
electrodes in propylene carbonate	CLEAN BURRGY
p0774 180-51690	Wind resource assessment in the upper Skagit River Valley of Washington
	p0675 A80-48319

Disposable catalysts in the solvent refined coal processes	A parametric study of 1000 MWe combined closed cycle MHD/system electrical power generating
p0676 A80-48381	plants '
Solar and wind energy - Its contribution to	[TH-78-E-91] p0742 N80-28931
meeting future power requirements	Coordinating fossil fuel research in matural gas
p0623- A80-50816	recovery
National Passive Solar Conference, 3rd, San Jose,	[PB80-169469] p0697 #80-29527
Calif., January 11-13, 1979, Proceedings	Intergenerational equity and conservation
p0626 A80-52826	[NASA-CR-163434] p0580 H80-29861
The potential and economics of wind energy - An	Solubility of selected major and minor elements
investigation commissioned by the International	from coal and fly ash accumulations
Energy Agency for the Federal Republic of Germany	[FB80-175334] p0580 H80-29926
p0689 A80-54077	Refining and upgrading of synfuels from coal and
Wind power. Citations from the BTIS data base	oil shales by advanced catalytic processes
[PB80-811433] p0748 N80-30956	[FE-2315-48] p0703 N80-31629
Wind power. Citations from the Engineering Index	Cogeneration Technology Alternatives Study (CTAS).
data base	Volume 3: Industrial processes
[PB80-811441] p0748 880-30957	[HASA-CR-159767] p0749 N80-31870
Fossil energy program	General application of the critical path method to
[ORBL-5630] p0707 880-31902	resource characterization and planning for
	underground coal mining
Wind characteristics program element [PNL-3211] p0754 N80-33073	
	[DOE/ET-11268/3] p0707 N80-32272
CLEAR POELS	Stack gas reheat evaluation
Development research program for clean industrial	[PB80-196850] p0593 N80-33980
and transportation fuels from coal	COAL DERIVED LIQUIDS
[PB-2514-31] p0691 N80-28554	Average chemical structure of mild hydrogenolysis
CLEANERS	products of coals
Cleaning agents and techniques for concentrating	p0679 A80-49628
solar collectors	Qualitative and quantitative assessment of
[SAND-79-7052] p0659 N80-33911	reaction models of coal hydrogenation
CLIMATE	p0679_A80-49629
Climate and energy: A comparative assessment of	Selectivity improvement in the solvent refined
the Satellite Power System (SPS) and alternative	coal process. I - Detailed first-stage reaction
energy technologies	studies - Coal mineral catalysis. II - Detailed
[DOE/ER-0050] p0581 M80-30914	second-stage reaction studies - Hydrotreating of
CLIMATOLOGY	coal liquids
The global 2000 report to the president. Entering	p0679 A80-49630
the twenty-first century. Volume 2: The	Production of light aromatics from coal hydrogenates
technical report trends in population, climate, gross national product, earth	p0680 180-49631 Hydrogen distribution and transfer in coal
resources, technology, and man environment interactions	hydrogenation systems [DOE/PC-30014/1] p0758 N80-29473
p0782 B80-32296	Production of synthetic liquids from coal, 1980 -
CLOSED CYCLES	2000. Preliminary study of potential impediments
Closed cycle MHD power plant and retrofit	[FE-3137-T1] p0696 N80-29510
optimization application	Research and development of an advanced process
p0717 A80-44231	for the conversion of coal to synthetic gasoline
Ocean thermal energy conversion - A general	and other distillate fuels
introduction	[FE-2306-38] p0696 N80-29513
p0718 A80-44599	Research and development of an advanced process
Westinghouse OTEC power systems	for the conversion of coal to synthetic gasoline
p0718 A80-44601	and other distillate fuels
The behavior of a closed-cycle gas turbine with	[FB-2306-35] p0696 N80-29514
time dependent operating conditions	Environmental data energy technology
[ASME PAPER 79-GT/ISR-2] p0720 A80-45663	characteristics: Synthetic fuels
Closed-cycle helium gas turbine for solar tower	[DOB/EV-0073] p0579 N80-29516
power plant	Investigation of mechanisms of hydrogen transfer
[ONESA, TP NO. 1980-28] p0597 A80-46228	in coal hydrogenation
The HTGR-GT closed-cycle gas turbine - A plant	[FE-2305-33] p0697 B80-29517
concept with inherent cogeneration /power plus	Partial liquefaction of coal by direct hydrogenation
heat production/ capability	[FE-2044-51] p0699 N80-30540
p0724 A80-48248	Refining and upgrading of synfuels from coal and
Power cycles analyses by generalized thermodynamic	oil shales by advanced catalytic processes.
properties	Laboratory and pilot plant studies of the
p0725 A80-48250	processing of SEC-1
Closed-cycle gas turbines for power generation and	[FB-2315-45] p0699 N80-30544
LNG vaporization	Opgrading of coal liquids: Hydrocracking of EDS
p0739 A80-52600	process derived gas oils
Evaluation of control strategies for solar	[PE-2566-33] p0699 N80-30545
collector loops	Refining and upgrading of synfuels from coal and
[LBL-10716] p0647 N80-31932	oil shales by advanced catalytic processes
CLOUD COVER	[FE-2315-48] p0703 N80-31629
Estimating solar irradiation sums from sunshine	Research and development of an advanced process
and cloudiness observations	for conversion of coal to synthetic gasoline and
p0625 A80-51685	other distillate motor fuels
COAL	[PR-1800-45] p0704 N80-31641
Processing of coal, oil sand and heavy oil in situ	Chemistry of lignite liquefaction
by electric and magnetic fields	[FE-2211-11] p0704 H80-31642
p0669 A80-44846	COAL GASIFICATION
Trace element characterization of coal wastes	Results from study of potential early commercial
[PB80-166150] p0577 N80-28488	MHD power plants and from recent BfF design work
Refining and upgrading of synfuels from coal and	Engineering Test Pacility
oil shales by advanced catalytic processes	p0717 180-44107
[FE-2315-40] p0691 N80-28550	Closed cycle MHD power plant and retrofit
Peasibility of alternatives for surface	optimization application
utilization of coal wastes [PE-3105-1] p0692 B80-28563	p0717 A80-44231 Coal gasification in fluidized bed combustion:
[FE-3105-1] p0692 B80-28563	Status and developments - Puture perspectives
·*	p0669 A80-45267
	P0003 800-43207

Methane formation during hydrogen gasification and gas phase pyrolysis of selected aromatics One-dimensional model for pulverized coal combustion and gasification Peasibility of a peat biogasification process p0669 A80-46197 p0689 A80-54034 p0669 A80-45322 Chemical and physical stability of refractories for use in coal gasification [COO-2904-15]
Alternative Gas Workshop p0690 N80-28478 The U.S. coal gasification program - Progress and pro jects p0670 180-46325 Highlights of the LLL Hoe Creek No. 3 underground [LA-8155-C] p0690 N80-28547 Cryogenic methane separation/catalytic hydrogasification process analysis
[FE-3044-T6] p0690 N80-28548
Kinetics and mechanisms of catalytic coal gasification experiment D0670 A80-46606 The direction and scope of the U.S. Department of Energy's surface coal gasification program hydroliquefaction and hydrogasification of lignite P0672 A80-48242 p0691 N80-28555 [FE-2702-8] Formation and control of fuel-nitrogen pollutants Solar coal qasification in catalytic combustion of coal-derived gases
[FE-2762-8] p0577 #80-28557 p0616 A80-48243 Plash pyrolysis and gasification of coal through laser heating Applied research and evaluation of process P0672 A80-48244 concepts for liquefaction and gasification of Past fluid bed coal gasification in a process western coals [ FE-2006-16] p0691 N80-28558 development unit . p0672 A80-48245 Alternative process schemes for coal conversion
[BNL-51117] p0692 N80-28560
Shift conversion and methanation in coal Historical development of the U-GAS process at the IGT pilot plant gasification: Bench-scale evaluation of a P0673 A80-48246 sulfur resistant catalyst [PE-3240-T4] Helium-topping/organic bottoming - Advanced power generation system Exergetic/energetic analysis p0692 N80-28561. P0673 A80-48247 Instrumentation and process control development Development of molten carbonate fuel cells for for in situ coal gasification p0692 N80-28562 power generation [SAND-80-0482] p0726 A80-48279 Development of alcohol-based synthetic The HYGAS process to produce pipeline gas from coal transportation fuels from coal-derived synthesis p0674 A80-48291 gases p0692 N80-28566 The CS/R advanced SNG hydrogasification process p0674 A80-48292 [DOE/ET-14858/T1] Experimental studies of some regularities in the underground gasification of inclined coal seams [UCRL-TRANS-11585] p0695 N80-29 Indirect liquefaction via the Avco coal gasification system p0695 N80-29504 P0674 A80-48296 Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed coal gasification Status of nuclear high temperature process heat development in the Federal Republic of Germany [GFETC/RI-80/2] /coal gasification and long distance energy p0695 N80-29507 Shift conversion and methanation in coal gasification: Bench-scale evaluation of a transport/ p0758 A80-48311 Results from the Hoe Creek No. 3 underground coal sulfur resistant catalyst [FE-3240-T5] p0696 N80-29509 Hydrogen production. Citations from the NTIS data gasification experiment p0675 A80-48340 Theory of reverse combustion along fissures in fuel which gasifies at depth hase [PB80-810476] p0665 Alloy catalysts with monolith supports for p0665 N80-29519 p0675 A80-48341 methanation of coal-derived gases successful eastern in situ coal gasification p0699 N80-30541 FE-2729-81 field trial P0675 A80-48342 Advanced coal gasification system for electric water-influx model for UCG with power generation [FE-1514-97] p0700 N80-30548 spalling-enhanced drying --- Underground Coal Applied research and evaluation of process concepts for liquefaction and gasification of Gasification P0676 A80-48343 An investigation of simultaneous heat and mass western coals p0700 280-30549 transfer in subbituminous coal --- hot gas drying for underground coal conversion [FE-2006-17] Materials technology for coal-conversion processes p0700 H80-30551 [ANL-80-12] P0676 A80-48344 Characterization of a potential underground coal gasification site in the State of Washington Molten salt coal gasification process development unit p0676 A80-48345
The flash hydropyrolysis of lignite and
sub-bituminous coals to both liquid and gaseous
hydrocarbon products FSAN-1429-521 p0700 N80-30554 Second phase of a coalbed methane extraction and utilization program [AESD-TME-3026] p0700 M80-30556 Coal processing for fuel cell utilization. Task 11: Pluidized bed coal gasification model: data D0679 A80-49626 Potentialities and limitations of future use of analysis and predictions
[METC-8450-T1] p0701 N80Investigation of sulfur-tolerant catalysts for coal for power generation p0701 N80-30909 P0685 A80-50817 Thermodynamic analysis of coal gasification processes selective synthesis of hydrocarbon liquids from coal-derived gases [FE-14809-1] p0702 #80-3 A study of industrial hydrogen and syngas supply p0702 N80-31502 Global model of countercurrent coal gasifiers push-pull test - A method of evaluating systems formation adsorption parameters for predicting the environmental effects on in-situ coal [NASA-CR-163523] p0666 880-31624 Pipeline gas from coal: Hydrogenation (IGT hydrogasification process) qasification and uranium recovery p0576 A80-52968 Relative merits of alternate linking techniques [PB-2434-33A] p0703 N80-31630 Molten salt coal gasification process development for underground coal gasification and their unit p0703 N80-31631 system design implications r san-1429-56 I p0688 A80-52969 Wesearch needs for coal gasification and coal Pittsburgh Energy Technology Center hydrogasification process: Conceptual commercial scale plant design [DOE/MC-08484/T1] liquefaction

P0688 A80-53274

p0703 N80-31633

COAL LIQUEFACTION SUBJECT INDEX

Advanced coal gasification system for electric:	Modeling of heat and mass transfer during coal
power generation	block gasification
[FE-1514-101] p0703 H80-31634	p0713 H80-33577 Single particle gas-solid reactions and their
Pipeline gas from coal: Eydrogenation (IGT hydrogasification process)	application to modeling of fluidized bed coal
[FE-2434-58] p0704 N80-31636	combustors and ash agglomerating gasifiers
Coal gasification pilot plant support studies	p0713 B80-33578
[FE-2806-5] p0704 N80-31637	Coal gasification combined-cycle system analysis
Advanced development of a short-residence-time	[EPRI-AP-1390] p0713 H80-33601
hydrogasifier	Energy policy: Supply and demand alternatives
[PB-3125-12] p0704 H80-31638	[GPO-56-541] p0591 N80-33870
Advanced development of a short-residence-time	COAL LIQUEFACTION
hydrogasifier	Status of coal hydrogenation in Europe
[PB-3125-18] p0704 N80-31639	p0669 A80-45512
Design, engineering and evaluation of refractory	Status of coal hydrogenation outside Europe
liners for slagging gasifiers	p0669, 180-45513
[IITRI-M6043-5] p07C4 M80-31640 Materials for coal conversion and use. Volume 2:	Indirect liquefaction via the Avco coal gasification system
Materials of construction for coal conversion	p0674 180-48296
systems. Part 1: Coal gasification. Fart 2:	Advanced process development in coal liquefaction
Coal liquefaction	p0676 180-48379
[FE-2468-59-VOL-2-PT-1/2] p0705 H80-31644	Advanced coal liquefaction processes emphasize low
Methane recovery from coalbeds project, phase 2	hydrogen consumption
[DOE/HC-08089/T4] p0705 H80-31645	p0676 A80-48380
Gasification of coal with solar energy	Approach to steady-state solvent composition in
[OCBL-84458] p0643 H80-31652	the SEC-I coal liquefaction process
Underground gasification for steeply dipping coal	p0676 180-48382
beds. Rawlins test no. 1 [SAN-13108-35] p0705 H80-31653	The Department of Energy's major project coal liquefaction program
LLL in situ coal gasification project	p0677 A80-48427
[UCRL-50026-79-4] p0705 880-31654	Assessment of current research and development in
Instrumentation and process control development	support of the U.S. coal liquefaction
for in situ coal gasification	demonstration plants program
[SAND-80-1025] p0706 N80-31655	p0677 A80-48428
Mixing and gasification of coal in entrained flow	H-Coal processing of Kentucky No. 11 coal and 1980
systems. Volume 2: User's manual for a	status of H-Coal
computer program for 1-dimensional coal	p0677 A80-48429
combustion or gasification (1-DICOG)	Exxon Donor Solvent Coal Liquefaction Process -
[FE-2666-P-VOL-2] p0706 N80-31656	Development Program Status p0677 180-48430
Development of molten carbonate fuel cell power plant technology	LC-Fining of solvent refined coal - SRC-I and
[DOE/ET-15440/1] p0750 N80-31938	short contact time coal extracts Lummus
Pollutants from synthetic fuels production: Coal	Cities Pining catalytic hydrogenation process
gasification screening test results	p0678 A80-48431
[PB80-182769] p0707 N80-31986	Heat transfer in slurry preheaters for coal
Coal gasification/gas cleanup test facility:	liquefaction plants
Volume 1. Description and operation	p0678 A80-48432
[PB80-188378] P0707 N80-31990	The flash hydropyrolysis of lignite and
Review of Department of Energy sponsored codes and documentation available from Purdue and Lehigh	sub-bituminous coals to both liquid and gaseous hydrocarbon products
Universities processes modeling contracts	p0679 A80-49626
[K/CSD/TM-35] p0707 N80-32278	Catalytic hydrogenation of Liddell bituminous coal
Condensation processes in coal combustion products	- Effects of process variables on coal
[DOE/BR-10456/1] p0708 880-32473	dissolution in batch autoclaves
Kinetics and mechanisms of catalytic	p0679 A80-49627
hydroliquefaction and hydrogasification of lignite	Qualitative and quantitative assessment of
[FE-2702-10] p0709 N80-32556	reaction models of coal hydrogenation
Advanced coal gasification system for electric	p0679 A80-49629 Selectivity improvement in the solvent refined
power generation [PE-1514-113] p0709 N80-32557	coal process. I - Detailed first-stage reaction
Use of an automated mass spectrometer for an	studies - Coal mineral catalysis. II - Detailed
underground coal gasification field test	second-stage reaction studies - Hydrotreating of
[UCRL-84366] p0709 N80-32565	coal liguids
Assessment of Synthane mechanical equipment	p0679 A80-49630
[MTI-79TR5] p0710 N80-32572	Production of light aromatics from coal hydrogenates
Plash pyrolysis and gasification of coal through	p0680 A80-49631
laser heating	Potentialities and limitations of future use of
[LA-UR-80-1094] p0711 H80-32573	coal for power generation p0685 A80-50817
Weld overlaying for corrosion resistance in coal gasification atmospheres	The hydropyrolysis of coal to BTX Benzene,
[PE-2621-13] p0711 880-32726	Toluene and Tylenes
High-temperature turbine technology program.	p0688 A80-53174
Overall Plant Design Description (OPDD) low-Btu	Research needs for coal gasification and coal
coal gas electric power plant	liquefaction
[PE-1806-83] p0752 880-32729	p0688 A80-53274
Assessment of sulfur removal processes for	Development of unique catalysts for
advanced fuel cell systems	hydrodenitrogenation of coal-derived liquids
[EPHI-EM-1333] p0752 N80-32866	[FE-3297-1] p0690 #80-28482 Development of unique catalysts for:
Environmental assessment report: Wellman-Galusha	hydrodenitrogenation of coal-derived liquids
low-Btu gasification systems [PB80-190796] p0589 B80-32995	anilines
Sorption properties of sediments and	[PE-3297-2] p0690 %80-28545
energy-related pollutants	Development of unique catalysts for
[PB80-189574] P0589 N80-32997	hydrodenitrogenation of coal-derived liquids
The pressurized fluidized bed gasification of coal	decahydroquinoline and quinoline
char	[PE-3297-3] p0690 N80-28546
[BLL-RTS-12347] p0712 N80-33575	Materials for coal liquefaction
The fluidized bed gasification of coal char	[ISM-246] p0690 M80-28549

SUBJECT INDEX COAL UTILIZATION

Development of new catalysts for coal liquids COAL UTILIZATION Parametric study of prospective early commercial refining
[FE-2595] [FE-2095] p0691 880-28553 Kinetics and mechanisms of catalytic hydroliquefaction and hydrogasification of lignite [FR-2702-8] D0691 880-2055 OCHHD power plants /PSPEC/ Some etching studies of the microstructure and composition of large aluminosilicate particles [PE-2702-8] p0691 N80-28555
Catalysts for upgrading coal-derived liquids
[DOE/ET-14876/2] p0691 N80-28556
Applied research and evaluation of process in fly ash from coal-burning power plants p0569 A80-45481 Pactors influencing the release of boron from coal concepts for liquefaction and gasification of western coals [ PB-2006-16 ] p0691 N80-28558 A study of the gaseous and particulate pollutants in the environment of a thermal power plant Development and application of analytical techniques to chemistry of donor solvent project area liquefaction p0570: A80-46150 Heat transfer as a diagnostic tool in the development of direct coal-fired HHD combustors [ASME PAPER 80-HT-125] p0722 A80-48 p0695 N80-29472 [FE-2696-T4] p0695 Catalyst development for coal liquefaction [BRRI-AF-1233] p0696 880-29508 Production of synthetic liquids from coal, 1980 -2000. Preliminary study of potential impediments [FR-3137-m1] p0722 A80-48040 mathematical model for the continuous combustion of char particles in a fluidized bed 2000. Preliminary study of potential impediments [PE-3137-T1] p0696 N80-29510 Research and development of an advanced process for the conversion of coal to synthetic gasoline and other distillate fuels [PE-2306-35] p0696 N80-29514 p0671 480-48168 Selecting fines recycle methods to optimize fluid bed combustor performance p0671 A80-48169 Methods of improving limestone utilization in Investigation of mechanisms of hydrogen transfer fluidized-bed combustion p0672 A80-48170 in coal hydrogenation [FE-2305-33] p0697 N80-29517 An engineering study on the use of regenerative calcium silicates sorbent for AFB power generation from high sulfur coal --- Atmospheric Partial liquefaction of coal by direct hydrogenation [PB-2044-51] p0699 N80-30540 Upgrading of coal liquids: Hydrocracking of EDS process derived gas oils Fluidized Bed p0672 180-48171

Hydration of 'spent' limestone and dolomite to [FE-2566-33] P0699 N80-30545 Upgrading of coal liquids for use as power enhance sulfation in fluidized-bed combustion generation fuels
[EPRI-AP-1225] p0699
Applied research and evaluation of process p0672 A80-48172 Open-cycle MHD generator channel development p0699 N80-30547 p0723 A80-48185 concepts for liquefaction and gasification of Development of steam generator components for western coals open-cycle MHD [PB-2006-17] p0700 N80-30549 p0723 A80-48186 Component Development and Integration Pacility - A Materials technology for coal-conversion processes [ANL-80-12] p0700 #80-30551 description and status report --- on coal-fired Thermophysical properties of coal liquids [BHI-2043] p0701 open cycle MHD plant [BEI-2043] p0701 m80-30557 Ultrasonic characterization of coal liquefaction p0723 A80-48187 Economic performance model of AFEC systems --products Atmospheric Pluidized Bed Combustion [DOE/PC-10346/1] p0702 M80-31503 Multiphase reactor modeling for zinc chloride catalyzed coal liquefaction p0571 A80-48199
Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities [LBL-9870] p0703 N80-316
Research and development of an advanced process
for conversion of coal to synthetic gasoline and
other distillate motor fuels p0703 N80-31628 p0672 A80-48200 Circulating fluidized bed boiler p0672 A80-48201 [FB-1800-45]
Chemistry of lignite liquefaction
[FB-2211-11] Design and operation of fluidised bed industrial boilers and hot gas producers p0704 N80-31641 p0704 N80-31642 p0672 #80-48202 Materials for coal conversion and use. Volume 2: Near term commercialization of MBD power Materials of construction for coal conversion generation using coal/oil fuel systems. Part 1: Coal gasification. Part 2: p0724 A80-48225 Liquid-metal MHD for solar and coal - System and Coal liquefaction p0705 N80-31644 [FE-2468-59-VOL-2-PT-1/2] component status Review of Department of Energy sponsored codes and documentation available from Purdue and Lehigh DO724 A80-48226 Removal of metals from coal ash Universities processes modeling contracts
[K/CSD/TM-35] p0707 N p0674 A80-48295 Ln/CSD/TH-35] p0707 H80-32278 Kinetics and mechanisms of catalytic hydroliquefaction and hydrogasification of lignite [FE-2702-10] Georgetown University's experience in the atmospheric fluidized hed combustor technology p0675 A80-48332 Sorption of moisture and methane on Fruitland coal
-- in underground coal conversion Catalyst characterization in coal liquefaction p0676 A80-48346 p0709 N80-32560 [SAND-80-0123] p0709 N80-3.
Investigation of mechanisms of hydrogen transfer Coal-fired fluid bed combustion augmented in coal hydrogenation, phase 2
[PB-2305-30] p0710 No
Development of new catalysts for coal liquid compressed air energy storage systems p0710 880-32568 p0768 A80-48376 Disposable catalysts in the solvent refined coal refining
[FE-2595-5] processes p0676 A80-48381 D0710 N80-32569 Coal liquefaction Design study of a coal-fired thermionic P0711 N80-32574 /THX/-topped power plant p0730 A80-48422 Reaction modelling and correlation for flash hydropyrolysis of lignite coal-derived liquid p0678 180-48433 Sulfate aerosol production and growth in p0712 N80-32728 [ FE-1806-84] Development and application of analytical techniques to chemistry of donor solvent coal-operated power plant plumes liquefaction p0572 A80-48533 Investing in coal --- international energy policy p0572 A80-49391 [DOB/PC-20041/T1] DO712 N80-33520 Rnergy policy: Supply and demand alternatives
[GPO-56-541] p0591 880-

p0591 N80-33870

•	•
The investment needs of the coal industry of the European Community	Climate and energy: A comparative assessment of the Satellite Power System (SPS) and alternative
p0573 A80~49399 Pollution control improvements in coal-fired electric generating plants - What they accomplies what they cost	energy technologies [DOB/ER-0050] p0581 H80-30914 Processes to increase utilization of power solid
accomplish, what they cost p0573 A60-49648 Efficiency of coal use, electricity for EVs versus	wastes [ISM-245] p0702 H80-30929 Pilot scale combustion evaluation of waste and
synfuels for ICEs [SAE PAPER 800109] p0680 A80-49727	alternate fuels, phase 3 [PB80-177413] p0702 B80-30952
The combined firing of coal and waste derived fuel in steam raising plant	Photochemical study of BOx removal from stack gases [PB80-181274] p0582 B80-30966
р0681 д80-49956	Combustion studies of coal-in-oil droplets
co-combustion trials of pretreated solid urban refuse, on a brown coal-fired boiler	[DOE/ET-10660/1] p0702 H80-31499 Bethane recovery from coalbeds project, phase 2
p0681 A80-49957 Co-firing densified refuse derived fuel in a	[DOE/MC-08089/T4] p0705 M80-31645  Recent coal-oil mixture combustion tests at PETC
spreader stoker fired boiler p0684 180-50018	[DOE/PETC-TR-80/5] p0706 B80-31658 Possil energy program
Strategies for rational utilization of bituminous coal deposits in the German Pederal Republic p0685 A80-50814	[ORNL-5630] p0707 N80-31902 Coal demonstration plants [DOE/FR-0004/79-2] p0709 N80-32555
Thermodynamic analysis of coal gasification processes	Design and development of Stirling engines for
p0686 A80-51210	stationary power generation applications in the 500 to 3000 horsepower range
The technical and economic aspects of brown coal refinement	\ [DOB/RT-15207/T1] p0752 B80-32723 Bigh-temperature turbine technology program.
p0686 A80-51498	Overall Plant Design Description (OPDD)
The renaissance of coal prospects and problems of increased worldwide utilization	coal-derived liquid [FE-1806-84] p0712 880-32728
p0689 A80-54036 Aspects of commercializing coal-derived methanol	High-temperature turbine technology program. Overall Plant Design Description (OPDD) low-Btu
fuels in the United States, 1985 to 2000.	coal gas electric power plant
Volume 1: Market evaluation [PE-2416-44-VOL-1] p0690 H80-28542	[FE-1806-83] p0752 880-32729
[PB-2416-44-VOL-1] p0690 H80-28542 Aspects of commercializing coal-derived methanol	A methodology for the environmental assessment of advanced coal extraction systems
fuels in the United States, 1985 to 2000.	[NASA-CB-163570] p0586 B80-32827
Volume 2: Appendix [PB-2416-44-VOL-2] p0690 N80-28543	Direct electrochemical generation of electricity from coal
Materials for coal liquefaction	[SAN-0115-105-1] p0752 N80-32865
[ISM-246] p0690 M80-28549 Survey of world coal energy studies and	Advanced technology fuel cell program [EPRI-EM-1328] p0752 B80-32877
international coal mining research [PB-2468-68] p0691 H80-28551	Open-cycle HHD systems analysis [EPRI-AP-1316] p0753 H80-32881
Investigation of fuels containing coal-oil-water emulsions fire tube test apparatus	Environmental control technology for carbon dioxide [DOE/EV-0079] p0588 880-32972
[DOE/ET-10634/T1] p0691 N80-28552	Organic material emissions from holding ponds at
Development research program for clean industrial and transportation fuels from coal	coal-fired power generation facilities [EPRI-EA-1377] p0589 #80-32987
[FE-2514-31] p0691 B80-28554	Miniplant and bench studies of pressurized
Development of high-temperature turbine subsystem technology to a technology readiness status,	fluidized-bed coal combustion [PB80-188121] p0712 M80-32999
phase 2	Optimal thermionic energy conversion with
[FE-1806-67] p0693 B80-28726 Environmental data energy technology	established electrodes for high-temperature topping and process heating coal combustion
characterizations: Coal	product environments
[DOE/EV-0074] p0577 N80-28882 The long-term effects of trace elements emitted by	[NASA-TH-81555] p0754 N80-33221 The pressurized fluidized bed gasification of coal
energy conversion of lignite coal	char
[PB80-168867] p0578 H80-28958 The long-term effects of trace elements emitted by	[BLL-RTS-12347] p0712 N80-33575 Cogeneration Technology Alternatives Study (CTAS).
energy conversion of lignite coal. Volume 2: Technical appendices	Volume 4: Energy conversion systems [NASA-CR-159768] p0755 N80-33859
[PB80-168875] p0579 N80-28960	Collecting fly ash from low sulphur coals: An
The direct use of coal. Volume 2, part A: Working papers, appendices 1-4	Overview of Australian experience p0592 #80-33932
[PB80-184518] p0697 N80-29520 The direct use of coal. Volume 2, part B:	Air Pollution control device configurations [PB80-193253] p0593 B80-33972
Working papers, appendices 7-9	Bealth requirements for advanced coal extraction
[PB80-184526] p0697 H80-29521 The direct use of coal. Volume 2, part C:	systems [NASA-CR-163625] p0714 N80-34093
Working papers, appendices 10-14 [PB80-184534] p0697 880-29522	COALESCING Combustion studies of coal-in-oil droplets
The direct use of coal. Volume 2, part D:	[DOE/BT-10660/1] p0702 B80-31499
Working papers, appendices 15-17 [PB80-184542] p0697 N80-29523	COASTAL CURRENTS The SWAB (Spectral Wave And Bar) program
Peat as a fuel at the proposed Central Marine Power Company 600 MW plant, volume 1	[PB80-196041] p0714 B80-34052 COASTAL WATER
[PB80-175185] p0697 N80-29524	Ocean thermal energy conversion /OTEC/ - A
Development of high-temperature turbine subsystem technology to a technology readiness status,	subscale test range p0740 180-53674
phase 2 [PE-1806-86] p0701 B80-30753	CONTING  The coating industry: Energy savings with
Performance of a diesel engine operating on raw	volatile organic compound emission control
coal-diesel fuel and solvent refined coal-diesel fuel slurries	[TID-28706] p0579 B80-29833 COATINGS
[CONS-3288-T6] P0701 N80-30758	Development of high temperature resistant, solar absorber surfaces
	[BMPT-PB-T-79-70] p0640 B80-29906

SUBJECT INDEX COMBUSTION PRODUCTS

COBALT COMPOUNDS	Hydration of 'spent' limestone and dolomite to
Solar selective black cobalt - Preparation,	enhance sulfation in fluidized-bed combustion
structure, and thermal stability	p0672 A80-48172
p0609 A80-46933	Economic performance model of AFEC systems
COGERERATION Thermionic topping of combined cycle powerplants	Atmospheric Fluidized Bed Combustion p0571 A80-48199
and cogeneration applications	Circulating fluidized bed boiler
p0730 A80-48423	p0672 A80-48201
Combined production of electrical energy and heat	Georgetown University's experience in the
in municipal refuse incinerators in the greater	atmospheric fluidized bed combustor technology
Paris area p0682 180-49965	coal-fired fluid bed combustion augmented
Cogeneration Technology Alternatives Study (CTAS).	compressed air energy storage systems
Volume 2: Analytical approach	p0768 A80-48376
[NASA-CR-159766] p0741 N80-28859	'Combustion performance of CVD silicon carbide
Cogeneration Technology Alternatives Study (CTAS).	thermionic diodes Chemical Vapor Deposition
Volume 6: Computer data. Part 1: Coal-fired' nócogeneration process boiler, section A	p0732 A80-48473
[NASA-CR-159770-PT-1-A] p0745 N80-30888	Co-combustion trials of pretreated solid urban refuse, on a brown coal-fired boiler
Cogeneration Technology Alternatives Study (CTAS).	p0681 A80-49957
Volume 6: Computer data. Part 1: Coal-fired	Advanced combustion systems for stationary gas
nocogeneration process boiler, section B	turbine engines. Volume 2: Bench scale
[BASA-CR-159770-PT-1-B] p0745 H80-30889 Cogeneration Technology Alternatives Study (CTAS).	evaluation [PB80-175607] p0744 B80-29922
Volume 6: Computer data. Part 2:	Advanced combustion systems for stationary gas
Residual-fired nocogeneration process boiler	turbine engines. Volume 4: Combustor
[NASA-CR-159770-PT-2] P0745 N80-30890	verification testing, addendum
Cogeneration Technology Alternatives Study (CTAS).	[PB80-179849] p0698 #80-30313
Volume 3: Energy conversion system	Pulse combustion technology for heating applications
characteristics [NASA-CR-159761] p0748 N80-31869	[ANI/EES/TH-85] p0707 N80-32467 Soot reduction in diesel engines by catalytic
Cogeneration Technology Alternatives Study (CTAS).	effects
Volume 3: Industrial processes	[BNL-27792] p0585 N80-32731
[HASA-CR-159767] p0749 H80-31870	COMBUSTION REFECTED TO
Peasibility study: Fuel cell cogeneration in a	Comparative analysis of the basic combustion
water pollution control facility, volume 1 [DOE/ET-12431/T1-VOL-1] p0749 N80-31922	characteristics of some heavy hydrocarbon fuels in application to aircraft gas turbine engines
Optimal thermionic energy conversion with	p0721 A80-47424
established electrodes for high-temperature	Heat transfer as a diagnostic tool in the
topping and process heating coal combustion	development of direct coal-fired MHD combustors
product environments	[ASHE PAPER 80-HT-125] p0722 A80-48040
[NASA-TH-81555] p0754 B80-33221 Cogeneration Technology Alternatives Study (CTAS).	Selecting fines recycle methods to optimize fluid bed combustor performance
Volume 4: Energy Conversion systems	p0671 A80-48169
[NASA-CR-159768] p0755 N80-33859	Over 50% efficiency achieved in gas turbine system
Cogeneration Technology Alternatives Study (CTAS).	using isothermal expansion
Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section A	p0724 A80-48249 Start-up consideration in utility use of a refuse
[NASA-CR-159770-PT-1] p0591 N80-33860	derived fuel
Cogeneration Technology Alternatives Study (CTAS).	p0673 A80-48276
Volume 6: Computer data. Part 2:	Worldwide survey of current experience burning
Residual-fired nocogeneration process boiler [NASA-CR-159770-PT-2] p0591 N80-33861	residual and crude oils in gas turbines [EPRI-AF-1243] p0693 N80-28724
COLD FLOW TESTS	[EPRI-AF-1243] p0693 H80-28724 Combustion studies of coal-in-oil droplets
Advanced coal gasification system for electric	[DOB/BT-10660/1] p0702 880-31499
power generation	Recent coal-oil mixture combustion tests at PETC
[FE-1514-101] p0703 880-31634 COLD WATER	[DOE/PETC-TE-80/5] p0706 #80-31658
Seasonal thermal energy storage of chilled water	The energy efficient engine project [NASA-TH-81566] p0585 N80-32395
in aquifers	Potential of diesel engine, emission technology
p0766 A80-48335	[PB80-192685] p0586 N80-32735
The economics of aguifer storage of chilled water	COMBUSTION PHYSICS
for air conditioning p0767 A80-48337	A mathematical model for the continuous combustion of char particles in a fluidized bed
The Cold Water Pipe - Ocean engineering status and	p0671 A80-48168
developments	Theory of reverse combustion along fissures in
p0740 A80-53684	fuel which gasifies at depth
COMBUSTION	p0675 180-48341
Mixing and gasification of coal in entrained flow systems. Volume 2: User's manual for a	Advanced combustion systems for stationary gas turbine engines. Volume 2: Bench scale
computer program for 1-dimensional coal	evaluation
combustion or gasification (1-DICOG)	[PB80-175607] p0744 N80-29922
[FE-2666-F-VOL-2] p0706 N80-31656	Miniplant and bench studies of pressurized
COMBUSTION CHAMBERS  Heat transfer as a diagnostic tool in the	fluidized-bed coal combustion [PB80-188121] p0712 N80-32999
development of direct coal-fired BED combustors	Single particle gas-solid reactions and their
[ASME PAPER 80-HT-125] p0722 A80-48040	application to modeling of fluidized bed coal .
Selecting fines recycle methods to optimize fluid	combustors and ash agglomerating gasifiers
bed combustor performance p0671 A80-48169	P0713 H80-33578 COMBUSTION PRODUCTS
Hethods of improving limestone utilization in	A mathematical model for the continuous commustion
fluidized-bed combustion	of char particles in a fluidized bed
p0672 A80-48170	p0671 A80-48168
An engineering study on the use of regenerative calcium silicates sorbent for APB power	Methods of improving limestone utilization in fluidized-bed combustion
generation from high sulfur coal Atmospheric	p0672 180-48170
Pluidized Bed	

p0672 A80-48171

COMPORT SUBJECT INDEX

An engineering study on the use of regenerative calcium silicates sorbent for AFB power generation from high sulfur coal —— Atmospheric Fluidized Bed	Potential for conversion of refuse to energy in Ontario Canada and the Provincial Energy from Waste program p0681 A80-49946
p0672 180-48171	Thermodynamic and economic analysis of heat pumps
Hydration of 'spent' limestone and dolomite to enhance sulfation in fluidized-bed combustion	for energy recovery in industrial processes [ASME PAPER 78-WA/HT-64] p0686 A80-52049
	[ASHE PAPRE 78-WA/HT-64] p0686 A80-52049 Research, development, and commercialization
p0672 A80-48172	
Start-up consideration in utility use of a refuse	activities on biomass energy in the United States
derived fuel	p0687 A80-52857
p0673 A80-48276	DOE view of solar power commercialization and
Sulfate in diesel exhaust p0575 A80-50528	applications p0629 A80-52870
	Environmental data for sites in the Mational Solar
Optimization problems of emission reduction in large fossil-fuel combustion facilities	Data Betwork sonitoring performance of solar
p0576 A80-51500	energy demonstration projects
Pormation and control of fuel-nitrogen pollutants	[SOLAB/0010-79/12] p0633 H80-28947
in catalytic combustion of coal-derived gases	Aviation turbine fuels, 1979
[FE-2762-8] p0577 B80-28557	[DOE/BETC-PPS-80/2] p0703 H80-31627
Feasibility of alternatives for surface	Solar Central Receiver Hybrid Power Systems
utilization of coal wastes	sodium-cooled receiver concept. Volume 2, book
[FB-3105-1] p0692 N80-28563	1: Conceptual design, sections 1 through 4
Pilot scale combustion evaluation of waste and	[DOB/ET-20567/1-2-BK-1] p0645 N80-31896
alternate fuels, phase 3	Solar Central Receiver Bybrid Power Systems
[PB80-177413] p0702 N80-30952	sodium-cooled receiver concept. Volume 2, book
Pipeline gas from coal: Hydrogenation (IGT	2: Conceptual design, sections 5 and 6
hydrogasification process)	[DOB/BT-20567/1-2-BK-2]. p0645 880-31897
[PB-2434-58] p0704 N80-31636	Energy analysis of geothermal-electric systems
Condensation processes in coal combustion products	[COO-5085-4] p0584 #80-31915
[DOE/ER-10456/1] p0708 N80-32473	Solar central receiver hybrid power systems
Collecting fly ash from low sulphur coals: An	sodium-cooled receiver concept. Volume 1:
Overview of Australian experience	Brecutive summary
p0592 H80-33932	[DOB/ET-20567/1-1] p0648 H80-31948
COMPORT	Residential photovoltaic systems: A review and
Human comfort and auxiliary control considerations	comparative evaluation of four independent
in passive solar structures	studies of potential concepts
[LBL-10034] p0640 H80-29903	[SAND-80-7010] p0648 H80-31949
COMBECIAL BREEK	Photovoltaic institutional issues study
Results from study of potential early commercial	[SAND-79-7054] p0584 N80-31950
MHD power plants and from recent BTF design work	US National Photovoltaics Program and applications
Engineering Test Facility	experiments in the intermediate sector
p0717 A80-44107	[SAND-80-0587C] p0654 N80-32935
Issues in OTEC connercialization	District heating and cooling systems for
p0719 A80-44606	communities through power plant retrofit
Energy utilization; World Energy Engineering	distribution network, volume 4 [COO-4977/1-VOL-4] p0753 H80-32942
Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers	[COO-4977/1-VOL-4] p0753 H80-32942 COMMUNICATION SATELLITES
p0570 A80-47585	Electrical power system for the SBS communication
High temperature heat pump applications -	satellite
Commercial, industrial, and with alternative	p0617 A80-48309
energy soutces	A study of a space communication system for the
p0670 A80-47590	control and monitoring of the electric
Photovoltaic systems design and performance	distribution system. Volume 1: Summary
for commercial applications	[NASA-CR-163477] p0760 N80-31268
p0611 A80-47597	COMPABISON
LNG cold, an unutilized energy potential	Selection of alternative central-station
tionia Notamal Co. for alletairlast-	
, Liquid Natural Gas for electric power plants	technologies for the Satellite Power System
p0671 180-47776	technologies for the Satellite Power System (SPS) comparative assessment
p0671 A80-47776 Hear term commercialization of MHD power	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EE-0052] p0580 N80-29887
p0671 180-47776  Hear term commercialization of MHD power generation using coal/oil fuel	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887 Comparative assessment of environmental welfare
p0671 180-47776  Bear term commercialization of MHD power generation using coal/oil fuel p0724 180-48225	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EE-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power
p0671 180-47776  Near term commercialization of MHD power generation using coal/oil fuel p0724 180-48225  The 100-kWp photovoltaic power system at Natural	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies
p0671 180-47776  Near term commercialization of MHD power generation using coal/oil fuel p0724 180-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580 N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581 N80-30915
p0671 180-47776  Near term commercialization of MHD power generation using coal/oil fuel p0724 180-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument p0615 180-48227	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EE-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EE-0055] Methodology for the comparative assessment of the
p0671 A80-47776  Near term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580.N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581 N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative
p0671 A80-47776  Wear term commercialization of MHD power generation using coal/oil fuel p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies
p0671 A80-47776  Near term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system  p0764 A80-48235  The commercial application of an OTEC Jacket	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EBF-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EBF-0055] p0581 N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951
p0671 180-47776  Bear term commercialization of MHD power generation using coal/oil fuel p0724 180-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 180-48227  Sodium-sulfur load leveling battery system p0764 180-48235  The commercial application of an OTEC Jacket /tower/ design	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580.N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581 N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951 Analysis of aluminum-air battery propulsion
p0671 A80-47776  Wear term commercialization of MHD power generation using coal/oil fuel p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design p0728 A80-48350	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles
p0671 A80-47776  Near term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580 N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581 N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951  Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCRL-83824] p0778 N80-32940
p0671 A80-47776  Bear term commercialization of MHD power generation using coal/oil fuel p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580.N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581.N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750.N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCRL-83824] COMPONENT RELIABILITY
p0671 A80-47776  Wear term commercialization of MHD power generation using coal/oil fuel p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48225  The commercial application of an OTEC Jacket /tower/ design p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CB-163049] p0750 N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCEL-83824] p0778 N80-32940 COMPONENT RELIABILITY Development of steam generator components for
p0671 A80-47776  Bear term commercialization of MHD power generation using coal/oil fuel p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580.N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581.N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750.N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCRL-83824] COMPONENT RELIABILITY
p0671 A80-47776  Near term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580.N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581.N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750.N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCRL-83824] p0778.N80-32940 COMPONENT RELIABILITY Development of steam generator components for open-cycle MBD
p0671 A80-47776  Wear term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  p0572 A80-49393	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CB-163049] p0750 N80-31951  Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCEL-83824] p0778 N80-32940  COMPONENT RELIABILITY Development of steam generator components for open-cycle HBD p0723 A80-48186  Component Development and Integration Facility - A
p0671 A80-47776  Bear term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580.N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581.N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750.N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCRL-83824] p0778.N80-32940 COMPONENT RELIABILITY Development of steam generator components for open-cycle MBD
p0671 A80-47776  Wear term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48225  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  p0572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CB-163049] p0780 N80-31951  Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCEL-83824] p0778 N80-32940  COMPONENT RELIABILITY  Development of steam generator components for open-cycle NBD p0723 A80-48186  Component Development and Integration Facility - A description and status report on coal-fired open cycle MBD plant
p0671 A80-47776  Bear term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  p0572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CB-163049] p0750 N80-31951  Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCBL-83824] p0778 N80-32940  COMPONENT REMIABILITY Development of steam generator components for open-cycle MHD  p0723 A80-48186  Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant  p0723 A80-48187
p0671 A80-47776  Bear term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  p0572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties  p0572 A80-49394  Pinancing of energy investments - Capital and	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580.N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581.N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750.N80-31951  Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCRL-83824] p0778.N80-32940  COMPONENT RELIABILITY Development of steam generator components for open-cycle MBD p0723.A80-48186  Component Development and Integration Facility - A description and status report on coal-fired open cycle MBD plant p0723.A80-48187  COMPOSITE STRUCTURES Thermal stress in a composite cylinder by finite
p0671 A80-47776  Wear term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  p0572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties p0572 A80-49394  Pinancing of energy investments - Capital and policy requirements of developing countries	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581 N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCRL-83824] p0778 N80-32940 COMPONENT RELIABILITY Development of steam generator components for open-cycle MED p0723 A80-48186 Component Development and Integration Facility - A description and status report on coal-fired open cycle MED plant  p0723 A80-48187 COMPOSITE STRUCTURES Thermal stress in a composite cylinder by finite difference technique solar concentrator
Near term commercialization of MHD power generation using coal/oil fuel  100-kWp photovoltaic power system at Natural Bridges National Monument  10615 A80-48227  Sodium-sulfur load leveling battery yestem p0764 A80-48227  Sodium-sulfur load leveling battery yestem p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  10728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  10572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties  10572 A80-49394  Financing of energy investments - Capital and policy requirements of developing countries p0573 A80-49395	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CB-163049] p0750 N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCEL-83824] p0778 N80-32940 COMPONENT BELIABILITY Development of steam generator components for open-cycle MHD p0723 A80-48186 Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant  p0723 A80-48187 COMPOSITE STRUCTURES Thermal stress in a composite cylinder by finite difference technique solar concentrator tubular heat exchanger
Bear term commercialization of MHD power generation using coal/oil fuel  100-kWp photovoltaic power system at Natural Bridges National Monument  10615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  10728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  10572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties p0572 A80-49394  Pinancing of energy investments - Capital and policy requirements of developing countries p0573 A80-49395  Trends in financing LNG projects	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580.N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581.N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750.N80-31951  Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCRL-83824] p0778.N80-32940  COMPONENT RELIABILITY Development of steam generator components for open-cycle MHD p0723.N80-48186  Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant  p0723.N80-48187  COMPOSITE STRUCTURES Thermal stress in a composite cylinder by finite difference technique solar concentrator tubular heat exchanger [ASMB PARES 80-HT-107] p0612.N80-48036
p0671 A80-47776  Near term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  p0572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties p0572 A80-49394  Pinancing of energy investments - Capital and policy requirements of developing countries p0573 A80-49395  Trends in financing LNG projects	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CB-163049] p0750 N80-31951  Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCEL-83824] p0778 N80-32940  COMPONENT RELIABILITY  Development of steam generator components for open-cycle MED p0723 A80-48186  Component Development and Integration Facility - A description and status report on coal-fired open cycle MED plant  p0723 A80-48187  COMPOSITE STRUCTURES  Thermal stress in a composite cylinder by finite difference technique solar concentrator tubular heat exchanger [ASME PAPER 80-HT-107] p0612 A80-48036  High energy density composite flywheel program
P0671 A80-47776  Wear term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery yestem p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  p0572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties p0572 A80-49394  Pinancing of energy investments - Capital and policy requirements of developing countries p0573 A80-49395  Trends in financing LNG projects  p0573 A80-49398  The investment needs of the coal industry of the	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581 N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCEL-3824] p0778 N80-32940 COMPONENT RELIABILITY Development of steam generator components for open-cycle HBD p0723 A80-48186 Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant  COMPOSITE STRUCTURES Thermal stress in a composite cylinder by finite difference technique solar concentrator tubular heat exchanger [ASMB PAPER 80-HT-107] p0612 A80-48036 High energy density composite flywheel program [AD-A087076] p0777 N80-31892
Bear term commercialization of MHD power generation using coal/oil fuel  100-kWp photovoltaic power system at Natural Bridges National Monument  10615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  10728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  10572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties p0572 A80-49394  Pinancing of energy investments - Capital and policy requirements of developing countries p0573 A80-49395  Trends in financing LNG projects  10573 A80-49398  The investment needs of the coal industry of the European Community	technologies for the Satellite Power System (SPS) comparative assessment [DOE/ER-0052] p0580.N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581.N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750.N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCRL-83824] p0778.N80-32940 COMPONENT RELIABILITY Development of steam generator components for open-cycle MHD p0723.N80-48186 Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant  p0723.N80-48187 COMPOSITE STRUCTURES Thermal stress in a composite cylinder by finite difference technique solar concentrator tubular heat exchanger [ASMB PAPER 80-HT-107] High energy density composite flywheel program [AD-A087076] p0777.N80-31892 COMPOSITION
P0671 A80-47776  Wear term commercialization of MHD power generation using coal/oil fuel  p0724 A80-48225  The 100-kWp photovoltaic power system at Natural Bridges National Monument  p0615 A80-48227  Sodium-sulfur load leveling battery yestem p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  p0728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  p0572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties p0572 A80-49394  Pinancing of energy investments - Capital and policy requirements of developing countries p0573 A80-49395  Trends in financing LNG projects  p0573 A80-49398  The investment needs of the coal industry of the	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951  Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCEL-83824] p0778 N80-32940  COMPONENT REMIABILITY  Development of steam generator components for open-cycle MED poff and Integration Facility - A description and status report on coal-fired open cycle MED plant  COMPOSITE STRUCTURES  Thermal stress in a composite cylinder by finite difference technique solar concentrator tubular heat exchanger [ASME PAPER 80-HT-107] p0612 A80-48036 High energy density composite flywheel program [AD-A087076] p0777 N80-31892  COMPOSITION  Bydrogen production by photoelectrolytic
Bear term commercialization of MHD power generation using coal/oil fuel  100-kWp photovoltaic power system at Natural Bridges National Monument  10615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  10728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  10572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties p0572 A80-49394  Pinancing of energy investments - Capital and policy requirements of developing countries p0573 A80-49395  Trends in financing LNG projects  10573 A80-49398  The investment needs of the coal industry of the European Community	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887 Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951 Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCEL-83824] p0778 N80-32940 COMPONENT RELIABILITY Development of steam generator components for open-cycle HBD p0723 A80-48186 Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant  P0723 A80-48187 COMPOSITE SIRUCTURES Thermal stress in a composite cylinder by finite difference technique solar concentrator tubular heat exchanger [ASHB PAPER 80-HT-107] p0612 A80-48036 High energy density composite flywheel program [AD-A087076] p0777 N80-31892 COMPOSITION Hydrogen production by photoelectrolytic decomposition of H20 using solar energy
Bear term commercialization of MHD power generation using coal/oil fuel  100-kWp photovoltaic power system at Natural Bridges National Monument  10615 A80-48227  Sodium-sulfur load leveling battery system p0764 A80-48235  The commercial application of an OTEC Jacket /tower/ design  10728 A80-48350  Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514  Capital requirements for energy in the industrialised countries  10572 A80-49393  Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties p0572 A80-49394  Pinancing of energy investments - Capital and policy requirements of developing countries p0573 A80-49395  Trends in financing LNG projects  10573 A80-49398  The investment needs of the coal industry of the European Community	technologies for the Satellite Power System (SPS) comparative assessment [DOE/EB-0052] p0580 N80-29887  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/EB-0055] p0581 N80-30915  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951  Analysis of aluminum-air battery propulsion systems for passenger vehicles [UCEL-83824] p0778 N80-32940  COMPONENT REMIABILITY  Development of steam generator components for open-cycle MED poff and Integration Facility - A description and status report on coal-fired open cycle MED plant  COMPOSITE STRUCTURES  Thermal stress in a composite cylinder by finite difference technique solar concentrator tubular heat exchanger [ASME PAPER 80-HT-107] p0612 A80-48036 High energy density composite flywheel program [AD-A087076] p0777 N80-31892  COMPOSITION  Bydrogen production by photoelectrolytic

COMPRESSED AIR	The OASIS computer program for optimization and
Computer aided optimal design of compressed air	simulation of integrated systems for energy
energy storage systems	production and utilization at community level
p0761 A80-45826	p0571 A80-48333
Development of a Compressed air energy storage	Analysis and design of free-piston Stirling
power generation plant - The PEPCO demonstration plant study	engines - Thermodynamics and dynamics p0729 A80-48407
p0767 A80-48338	An algorithm for the preliminary design of
The economics of compressed air energy storage	Stirling engine heaters
with thermal energy storage	p0730 A80-48411
p0767 180-48339	The Spheromak fusion reactor
Coal-fired fluid bed combustion augmented compressed air energy storage systems	p0733 A80-48495 Validation of published Stirling engine design
p0768 A80-48376	methods using engine characteristics from the
Porous media experience applicable to field	literature
evaluation for compressed air energy storage	p0734 A80-48497
[PNL-3294] p0777 N80-32873	Nodal analysis of miniature cryogenic coolers
COMPRESSIBLE FLOW WIND: Computer program for calculation of three	p0734 A80-48500 Energy conservation and solar houses
dimensional potential compressible flow about	p0623 A80-50941
wind turbine rotor blades	OTEC power system modeling, analysis and design
[WASA-TP-1729] p0755 N80-33357	via geometric programming
COMPRESSORS	p0739 A80-52048
Magnetoplasma compressor with an explosion-driven magnetic power generator	Coal processing for fuel cell utilization. Task 11: Fluidized bed coal gasification model; data
p0717 A80-44185	analysis and predictions
Assessment of hydrogen compressor technology for	[HETC-8450-T1] p0701 H80-30909
energy storage and transmission systems	Supplementary material on passive solar heating
[ORO-5598-T1] p0667 N80-32922	concepts: A compilation of published articles.
COMPUTATIONAL PLUID DYNAMICS Study of the insulating wall boundary layer in a	Presented in conjunction with a series of passive solar heating seminars sponsored by the
Faraday MED generator	Solar Energy Technology Transfer program
p0722 180-47763	[PNL-SA-7820] p0642 H80-30920
COMPUTER PROGRAMMING	Characterization of open-cycle, coal-fired MHD
The use of computer-controlled manipulators in	generators
underwater technology [DFVLR-MITT-78-02] p0714 #80-34117	[ARI-RP-43] p0750 B80-31936 COMPUTERIZED SIMULATION
COMPUTER PROGRAMS	Numerical simulation of dual-media thermal energy
The OASIS computer program for optimization and	storage systems
simulation of integrated systems for energy	[ASME PAPER 79-HT-35] . p0761 A80-45725
production and utilization at community level	Computer simulation of solar pond thermal behavior
p0571 180-48333 Applications of DOE-1 to passive solar heating of	p0599 A80-46567 Simulation and a preliminary comparison of passive
commercial buildings - Preliminary results	solar heating systems
p0626 A80-52831	[ASME PAPER 80-HT-17] p0611 A80-48008
Potential for hydropower development at existing	Computer simulation of solar panel voltage
dams in New England. Volume 2: User's manual	regulation
[PB80-169139] p0578 #80-28935 Three computer codes to read, plot and tabulate	p0612 A80-48177 Simulation of mass transfer processes in
operational test-site recorded solar data	geothermal power cycles with direct contact heat
[NASA-TH-78293] p0644 N80-31879	exchange
Characterization of open-cycle, coal-fired MHD	p0724 A80-48222
generators [ABI-BP-46] p0751 N80-32234	Development of the high temperature air heater for
Review of Department of Energy sponsored codes and	open cycle MHD p0724 A80-48224
documentation available from Purdue and Lehigh	Wind energy capacity of a single airfoil with
Universities processes modeling contracts	vertical axis on a circular track
[K/CSD/TM-35] p0707 H80-32278	p0673 A80-48274
A computer model of solar panel-plasma interactions [NASA-CR-160796] p0650 N80-32853	A thermodynamic analysis of a metal hydride heat pump
Solar index generation and delivery	p0661 A80-48290
[DOE/ET-20090/3] p0654 N80-32929	The CASIS computer program for optimization and
WIND: Computer program for calculation of three	simulation of integrated systems for energy
dimensional potential compressible flow about wind turbine rotor blades	production and utilization at community level p0571 A80-48333
[NASA-TP-1729] p0755 H80-33357	Simulation and evaluation of latent heat thermal
The SWAB (Spectral Wave And Bar) program	energy storage heat pump systems
[PB80-196041] p0714 880-34052	p0771 A80-48478
COMPUTER SYSTEMS DESIGN	An analytical solution for a Stirling machine with an adiabatic cylinder
General application of the critical path method to resource characterization and planning for	
underground coal mining	
[DOE/ET-11268/3] p0707 N80-32272	p0734 A80-48501 A simulation model for wind electric systems
	A simulation model for wind electric systems p0734 A80-48522
COMPUTER TECHNIQUES	A simulation model for wind electric systems p0734 A80-48522 Distributed series resistance in photovoltaic
COMPUTER TECHNIQUES  Manual and programmable calculator methods for	A simulation model for wind electric systems p0734 A80-48522 Distributed series resistance in photovoltaic devices - Intensity and loading effects
COMPUTER TECHNIQUES	A simulation model for wind electric systems p0734 A80-48522 Distributed series resistance in photovoltaic
COMPUTER TECHNIQUES  Hanual and programmable calculator methods for sizing solar energy systems  [EPRI-ER-1282-58] p0632 N80-28890  COMPUTERIZED DESIGN	A simulation model for wind electric systems p0734 A80-48522 Distributed series resistance in photovoltaic devices - Intensity and loading effects p0624 A80-51118
COMPUTER TECHNIQUES  Manual and programmable calculator methods for sizing solar energy systems [EPRI-ER-1282-5E] p0632 N80-28890  COMPUTERIZED DESIGN Computer aided optimal design of compressed air	A simulation model for wind electric systems p0734 A80-48522 Distributed series resistance in photovoltaic devices - Intensity and loading effects p0624 A80-51118 The effect of design parameter changes on the performance of thermal storage wall passive systems
COMPUTER TECHNIQUES  Hanual and programmable calculator methods for sizing solar emergy systems  [EPEI-ER-1282-5E] p0632 M80-28890  COMPUTERIZED DESIGN  Computer aided optimal design of compressed air energy storage systems	A simulation model for wind electric systems p0734 A80-48522 Distributed series resistance in photovoltaic devices - Intensity and loading effects p0624 A80-51118 The effect of design parameter changes on the performance of thermal storage wall passive systems  p0626 A80-52829
COMPUTER TECHNIQUES  Manual and programmable calculator methods for sizing solar energy systems [EPRI-ER-1282-5R] p0632 N80-28890  COMPUTERIZED DRSIGN Computer aided optimal design of compressed air energy storage systems  p0761 A80-45626	A simulation model for wind electric systems p0.734 A80-48522  Distributed series resistance in photovoltaic devices - Intensity and loading effects p0.624 A80-51118  The effect of design parameter changes on the performance of thermal storage wall passive systems  p0.626 A80-52829  Dynamic simulation and development of a control
COMPUTER TECHNIQUES  Hanual and programmable calculator methods for sizing solar emergy systems  [EPEI-ER-1282-5E] p0632 M80-28890  COMPUTERIZED DESIGN  Computer aided optimal design of compressed air energy storage systems	A simulation model for wind electric systems p0.734 A80-48522 Distributed series resistance in photovoltaic devices - Intensity and loading effects p0.624 A80-51118 The effect of design parameter changes on the performance of thermal storage wall passive systems  p0.626 A80-52829 Dynamic simulation and development of a control strategy for a distributed, concentrating solar collector field
COMPUTER TECHNIQUES  Hanual and programmable calculator methods for sizing solar energy systems  [EPEL-ER-1282-SE] p0632 M80-28890  COMPUTERIZED DESIGN  Computer aided optimal design of compressed air energy storage systems  p0761 A80-45626  Volume optimization of sodium-sulfur batteries using various advanced cell concepts  p0764 A80-48236	A simulation model for wind electric systems p0.734 A80-48522  Distributed series resistance in photovoltaic devices - Intensity and loading effects p0.624 A80-51118  The effect of design parameter changes on the performance of thermal storage wall passive systems  p0.626 A80-52829  Dynamic simulation and development of a control strategy for a distributed, concentrating solar collector field  p0.629 A80-53571
COMPUTER TECHNIQUES  Hanual and programmable calculator methods for sizing solar energy systems  [EPEI-ER-1282-SE] p0632 N80-28890  COMPUTERIZED DESIGN  Computer aided optimal design of compressed air energy storage systems  p0761 N80-45626  Volume optimization of sodium-sulfur batteries using various advanced cell concepts	A simulation model for wind electric systems p0.734 A80-48522 Distributed series resistance in photovoltaic devices - Intensity and loading effects p0.624 A80-51118 The effect of design parameter changes on the performance of thermal storage wall passive systems  p0.626 A80-52829 Dynamic simulation and development of a control strategy for a distributed, concentrating solar collector field

CONCENTRATING SUBJECT IEDEX

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A new probabilistic simulation technique for	Dual curvature acoustically damped concentrating collector
multiple energy storage devices for electric utility generation system expansion planning models	[DOB/CS-34196/T1] p0647 #80-31921 Terrestrial photovoltaic power systems with
p0774 H80-28855 Thermal energy storage systems using fluidized bed	sunlight concentration [SAHD-80-7008] p0648 H80-31942
heat exchangers [NASA-CR-159868] p0775 N80-28866	Fundamentals and techniques of nonimaging optics for solar energy concentration
Hybrid vehicle potential assessment. Volume 3: Parallel systems	[DOE/ER-04657/2] p0652 N80-32896 Spectral character of solar and circumsolar
[CONS-4209-T1-YOL-3] p0776 H80-31270 Solar domestic hot water system, a comparative study and storage tank investigation	radiation for application to concentrating solar energy systems [LBL-10802] p0653 #80-32916
. p06A3 N8O-31868	Concentrating photovoltaics for the tropics
Fluid temperature control for parabolic trough solar collectors [SAND-79-2006C] p0652 N80-32894	[DOE/CS-04270/1] p0656 #80-32954 Design data brochure for a pyramidal optical solar system
Development of an energy consumption and cost data base for fuel cell total energy systems and	[NASA-CR-161202] p0657 B80-33865 An evaluation of spectrally selective reflectors
conventional building energy systems [ORNL/CON-38] p0754 M80-32960	(cold mirror membranes) for use with concentrator solar arrays
CONCRITRATING Gallium arsenide solar cells for very high	p0659 N80-33900 Cleaning agents and techniques for concentrating
concentration systems: Recent results, problems and expectations	solar collectors [SAND-79-7052] p0659 N80-33911
[CISE-1518] p0649 N80-31962	COMBRESERS (LIQUIPIERS)  Condenser designs for binary power cycles in
Reduction of intensity variations on the absorbers	geothermal energy conversion
of ideal flux concentrators p0598 180-46452	P0723 A80-48221
Generalization of the two-dimensional optical analysis of cylindrical concentrators p0599 A80-46566	Condensation processes in coal combustion products [DOE/ER-10456/1] p0708 N80-32473 CONDUCTING PLUIDS
Photovoltaic generators using optical concentration p0604 A80-46739	End zone of a frame-type channel with an inhomogeneous flow current and potential
Fluorescent planar concentrators - Performance and experimental results solar collector	fields in plasma p0739 A80-52555
absorbing diffuse and direct radiation via	COMDUCTIVE HEAT TRANSFER Simulation of mass transfer processes in
fluorescent molecules  p0604 A80-46741  Solar cells with concentrating collectors and	geothermal power cycles with direct contact heat exchange
integrated heat use system p0604 180-46742	p0724 A80-48222 Coal processing for fuel cell utilization: Task
Numerical modelling of a solar cell in three dimensions p0605 A80-46749	9: One-dimensional (streamtube) model for entrained-flow gasifier analysis [MBTC-8450-T2-VOL-1] p0707 B80-31912
High efficiency silicon solar cell for concentrator systems	COMPERENCES  Photovoltaic Solar Energy Conference, 2nd, Berlin,
p0606 A80-46767 Cassegrain solar concentrators for photovoltaics	West Germany, April 23-26, 1979, Proceedings p0600 A80-46694
p0608 A80-46791  20 kW gallium arsenide photovoltaic dense array for central receiver concentrator applications p0608 A80-46793	Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers p0570 A80-47585
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy	Energy to the 21st century; Proceedings of the Fifteenth Intersociety Energy Conversion
p0610 A80-46952  Irradiance on the receiver of a general optical concentrator	Engineering Conference, Seattle, Wash., August 18-22, 1980. Volumes 1, 2 and 3 p0722 A80-48165
p0610 A80-47043 Note on the condensation of the vapor phase above	Recycling World Congress, 2nd, Manila, Philippines, March 19-22, 1979, Proceedings
a melt of iron oxide in a solar parabolic concentrator	p0678 180-49537 Becycling Berlin '79; Proceedings of the
p0611 A80-47664 Thermal stress in a composite cylinder by finite difference technique solar concentrator	International Congress, Berlin, West Germany, October 1-3, 1979. Volumes 1 & 2 p0680 A80-49926
tubular heat exchanger	Remote sensing and mineral exploration;
[ASME PAPER 80-HT-107] p0612 A80-48036 Heat-rejection design for large concentrating solar arrays	Proceedings of the Workshop, Bangalore, India, May 29-June 9, 1979 p0686 A80-51076
p0614 A80-48211 Concentrators and solar photovoltaics	Second law analysis of energy devices and processes; Proceedings of the Workshop, George
p0622 A00-50626 Gallium arsenide solar cells for use in	Washington University, Washington, C.C., August 14-16, 1979
concentrated sunlight p0628 A80-52864	p0576 A80-51202 A new era in technology; Proceedings of the
A study on utilizing solar energy for hydrogen production p0665 A80-53569	Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980 p0781 A80-51926
Conceptual design study of concentrator enhanced solar arrays for space applications. 2kW Si and	National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings
Gals systems at 1 AU [NASA-CR-163046] p0630 N80-28863	p0626 A80-52826 Biomass for energy Book
Long-term average performance benefits of paraholic trough improvements [SERI/TR-632-439] p0632 N80-28893	p0687 A80-52851 Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September
Optical analysis of point focus parabolic radiation concentrators	28, 1979 p0628 180-52860
[SERI/TR-631-336] p0646 #80-31917	

SUBJECT INDEX COPPER OXIDES

·	
Solar Power Generation Conference, San Jose,	CONTINENTAL SHRLVES
Calif., August 8, 9, 1979, Proceedings	South Atlantic OCS physical oceanography, volume 2
p0629 A80-52867 Heat transfer - San Diego 1979; Proceedings of the	monitoring ocean currents and sea states to assess effects of oil and gas activities on the
Righteenth National Conference, San Diego,	environment
Calif., August 5-8, 1979	[PB80-181555] p0582 N80-31026
p0781 A80-53568	South Atlantic OCS physical oceanography, volume 3
Aircraft Research and Technology for Future Fuels [NASA-CP-2146] p0654 N80-29300	monitoring ocean currents and sea states to
[MASA-CP-2146] p0654 M80-29300 Ceramics for turbine engine applications	assess the environment effects of oil and gas activities
[AGARD-CP-276] p0743 N80-29342	[PB80-181563] p0583 M80-31027
Energy/Environment 4: Proceedings of the National	COSTROL RQUIPHEST
Conference on the Interagency Energy/Environment	Power processing and control requirements of
R and D Program [PB80-177942] p0581 B80-29928	dispersed solar thermal electric generation
Workshop on Satellite Power Systems (SPS) Effects	systems p0619 A80-48465
on Optical and Radio Astronomy	The advantages of using an incineration regulation
[COMP-7905143] p0643 N80-31435	system to control the emission of toxic gases
Low-cost solar array project and Proceedings of the 15th Project Integration Meeting	and steam generation in refuse incineration plants
[NASA-CR-163568] p0650 N80-32852	CONTROL SIMULATION p0574 A80-49961
Synchronous Energy Technology	Feasibility studies of spoiler and aileron control
[NASA-CP-2154] p0656 N80-33465	systems for large horizontal-axis wind turbines
Photovoltaic generators in space conference	p0727 A80-48318
proceedings, Reidelberg, 15-17 Apr. 1980 [ESA-SP-147] p0658 N80-33873	Dynamic simulation and development of a control strategy for a distributed, concentrating solar
International Conference on Air Pollution, volume 1	collector field
[ISBN-0-7988-16651] p0592 N80-33929	p0629 A80-53571
CONGRESSIONAL BEPORTS	CONTROLLED PUSION
Laser technology: Development and applications [GPO-59-826] p0781 N80-29694	On fusion alpha-particle heating of plasma below
[GPO-59-826] p0781 880-29694 DOE authorization, 1981, volume 2	ignition p0718 A80-44429
[GPO-61-774-VOL-2] p0581 N80-30224	Tokamak poloidal field systems
NASA authorization, 1981, volume 5	[LA-8375-PR] p0754 N80-33233
[GPO-61-213-VOL-5] p0581 N80-30225	CONVECTIVE MEAT TRANSPER
National Aeronautics and Space Administration	Numerical simulation of dual-media thermal energy , storage systems
Authorization Act, 1981 [PUB-LAW-96-316] p0581 N80-30226	[ASHE PAPER 79-HT-35] p0761 A80-45725
First report to Congress on the use of alcohol in	Convective-radiative interaction in a parallel
motor fuels	plate channel - Application to air-operated
[DOE/CS-0165] p0708 N80-32548	solar collectors
Oversight: Alternate liquid fuels technology [GPO-50-313] p0590 B80-33580	p0598 A80-46349 Heat and mass transfer processes during the
Oversight: Cost estimation techniques for	pyrolysis of antrim oil shale
emerging synthetic fuels technology, volume 9	[ASME PAPER 80-HT-123] p0671 A80-48039
[GPO-51-721] p0590 N80-33581	Analysis of a passive heat pipe cooled solar
Energy policy: Supply and demand alternatives [GPO-56-541] p0591 N80-33870	photovoltaic receiver [SAND-80-7011] p0651 880-32885
Incentives for energy conservation	Line-focus solar central power system, phase 1.
[GPO-55-634] p0591 N80-33871	Subsystem experiment: Receiver heat transfer
Oversight: Wind energy program	[DOE/ET-20550/1] p0655 N80-32945
[GPO-51-382] p0591 N80-33872 Conservation and solar energy programs of the	COOLING
Department of Energy: A critique	Analysis of a passive heat pipe cooled solar photovoltaic receiver
[PB80-197759] p0591 880-33922	[SAND-80-7011] p0651 N80-32885
CONSTRUCTION MATERIALS	COOLING SYSTEMS
Materials-related design issues in the solar	Internally cooled cabled superconductors. I
central receiver pilot plant	for applications to fusion reactors and MHD generators
Materials for coal conversion and use. Volume 2:	p0720 A80-45054
Materials of construction for coal conversion	Working fluids for solar, Rankine-cycle cooling
systems. Part 1: Coal gasification. Part 2:	systems
Coal liquefaction [PB-2468-59-VOL-2-PT-1/2] P0705 880-31644	p0595 A80-45299 On calculating gas turbine efficiency reduction
CONSUMERS	under the influence of air cooling
Environmental assessment. Energy efficiency	p0721 A80-47415
standards for consumer products	Universal thermoelectric design curves of heat
[DOB/CS-0168] p0589 N80-32988 COBTANIBARTS	pumps
Summary of Solar Experience with the Soiling of	p0731 A80-48435 Nodal analysis of miniature cryogenic coolers
Optical Surfaces	p0734 A80-48500
[SBRI/TP-334-478] p0639 H80-29894	A classification scheme for the common passive and
Energy savings by means of fuel cell electrodes in	hybrid heating and cooling systems
electro-chemical industries [COO-4881-12] p0745 N80-30902	p0627 A80-52835 Some advantages of methane in an aircraft gas
Determination of air pollutant emission factors	turbine
for thermal tertiary oil recovery operations in	[NASA-TM-81559] p0695 N80-29502
California, volume 1	Overview-absorption/Rankine solar cooling program
[PB80-187594] p0585 B80-31982 Determination of air pollutant emission factors	[LBL-10770] p0640 N80-29904 COPPER
for thermal tertiary oil recovery operations in	Emerging materials systems for solar cell
California. Volume 2: Appendix	applications: Cu/sub 2-x/Se
PB80-187602] p0585 N80-31983	[DOE/ET-23005/T3] p0632 N80-28895
Pollutants from synthetic fuels production: Coal gasification screening test results	COPPER CXIDES Preparation and analysis of Cu20 thin-film solar
[PB80-182769] p0707 H80-31986	cells
•	p0607 A80-46781

COPPRE SULPIDES SUBJECT INDEX

A hybrid water-splitting cycle using copper sulfate and mixed copper oxides	A study of a space communication system for the control and monitoring of the electric
p0664 A80-48503	distribution system. Volume 1: Summary
Investigation of low-cost solar cells based on Cu20	[NASA-CR-163477] p0760 N80-31268
[DOE/ET-23006/3] p0653 860~32915 COPPER SULFIDES	Electric and hybrid vehicle system research and development project, hybrid vehicle potential
The spectral response of CdS:Cu/x/S solar cells	assessment. Volume 6: Cost analysis
formed by dry barrier techniques p0597 A80~46251	[COMS-4209-T1-VOL-6] p0583 H80-31274 Investigation of learning and experience curves
Optimal material properties for CdS/Cu2S solar cells	[SERI/TR-353-459] p0646 B80-31911
p0603 A80-46726	Automatic-control system for the 17-metre Vertical
Model for the photovoltaic effect in Cu2S-CdS solar cells in the backwall configuration	Axis Wind Turbine (VAWT) [SAED-78-0984] p0750 B80-31958
p0607 A80-46775	Photovoltaic applications definition and
Optical and calorimetric measurements of cupreous sulphides thin films —— for solar cells	photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes
p0607 180-46779	[SAND-79-7018/3] p0652 N80-32891
I-V relationship for the Cu2S/CdS solar cell	Costing methodologies for energy systems [BHL-27603] p0778 H80-32900
p0609 A80~46937 Theoretical investigations into collection	[BHL-27603] p0778 H80-32900 Environmental assessment report: Wellman-Galusha
coefficient for Cu/2-x/S-CdS cells with	low-Btu gasification systems
allowance for surface states at interface p0610 A80-47151	[FB80-19C796] p0589 B80-32995 COST EPPECTIVENESS
Optimized grid patterns for Cu2S-CdS solar cells	Modelling the competitiveness of first generation
p0621 A80~49322	commercial OTEC power plants p0718 A80-44605
Characterization of open-cycle, coal-fired MHD	Gals solar cells for space applications
generators	p0613 A80-48203
[ARI-RP-43] p0750 N80-31936	Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource
Economic evaluation of the HIT process for	p0725 A80-48267
manufacture of ethanol [DSR-3992-T1] p0705 #80-31647	Interim status report on DOB prototype development SWECS Small Wind Energy Conversion Systems
Liquid fuels production from biomass corn and	p0726 A80-48270
algae [COO-4388-10] p0708 N80-32545	Wind energy for electric webicle recharge p0726 A80-48273
CORROSION	Economics of wood energy systems for industries
Study program for encapsulation materials interface for low cost silicon solar array	p0673 A80-48275 Alternatives for heat supply in biomass energy
[HASA-CR-163583] p0651 H80-32857	conversion systems
Lead batteries. Citations from the HTIS data base	p0673 A80-48277
[PB80-813363] p0780 M80-33923 Lead batteries. Citations from the Engineering	Development status and utility of the sulfuric acid chemical heat pump/chemical energy storage
Index data base	syste∎
[PB80-813371] p0780 880-33924 CORROSION RESISTANCE	p0765 A80-48288 Status of electrochemical energy storage systems
Weld overlaying for corrosion resistance in coal	for electric vehicle, solar, and electric
gasification atmospheres [PB-2621-13] p0711 N80-32726	utility applications p0765 A80-48325
COST AVALYSIS	Solar pords for district heating and electricity
Parametric study of prospective early commercial OCMED power plants /PSPEC/	generation p0618 180-48367
p0717 A80-44106	Development of a bipolar Zn/Br2 battery
Photovoltaics commercialization readiness assessment p0607 A80-46772	p0767 A80-48369 Performance and structural characteristics of the
Air/rock storage for solar central receiver power	iron-air battery system for electric vehicle
stations -0.613 NRO MOING	propulsion
p0613 180-48196 Low maintenance lead-acid batteries for energy	p0767 A80-48371 The aluminum-air battery for electric vehicle
storage	propulsion
p0765 A80-48326 Sandia battery program for energy storage in	p0768 A80-48373 Residential photovoltaic flywheel storage system
photovoltaic systems	performance and cost
p0767 A80-48368 An energy and cost analysis of residential heat	p0768 A80-48377 New separator materials for nickel-cadmium
pumps in northern climates	aircraft batteries
p0571 A80-48426 Energy conservation measures for commercial	p0772 A80-48484 Photovoltaics in the U.S.A A progress report
buildings used in life cycle cost analysis	p0629 A80-52866
p0571 A80-48514 Conversion system overview assessment. Volume 3:	Bigh concentration solar collector of the stepped spherical type - Optical design characteristics
Solar thermal/coal or biomass derived fuels	p0629 A80-53263
[SERI/TR-35-078-VOL-3] p0630 N80-28569 A new probabilistic simulation technique for	Cost-effective ways to improve the fabrication and installation of solar heating and cooling
multiple energy storage devices for electric	systems for residences
utility generation system expansion planning nodels	[COO-4520-1] p0632 N80-28902
p0774 B80-28855	Internally insulated thermal storage system development program
Steam engine analysis p0743 880-29741	[SAND-80-8175] p0775 M80-28924
Blectric utilities and residential solar systems	Solar *trium: À hybrid solar heating and cooling system
[BML-27711] p0638 N80-29888	[ALO-4135-T2] p0639 N80-29899
Research and evaluation of biomass resources/conversion/utilization systems	Design and development of Stirling engines for stationary power applications in the 500 to 3000
(market/experimental analysis for development of	hp range. Subtask 1A report: State-of-the-art
a data base for a fuels from biomass model) [DOE/BT-20611/11] p0700 H80-30552	conceptual design [DOE/ET-15209/T1] p0744 R80-30755

SUBJECT INDEX CATOGRAICS

Assessment of industrial energy conservatio unit processes		Operation and maintenance cost data residential photovoltaic modules/	
[ORAU/IRA-80-4(M)] p0584 Deep space network energy program	B80-31939	[ NASA-CR-163585] COUPLED BODES	p0650 #80-32855
p0590	N80-33446	Stability and dynamic response to g	
OST ESTIMATES An update of OTEC baseline design costs		forces of the flapping and lead-la rigid rotor blade with the leading	
p0718	A80-44604	attack and flapping being coupled	
Solar power satellites - The present and th	e future	[ISD-244]	p0747 N80-30949
A system consideration of alternative bydro	A80-47562 gen	CRACKING (CBEMICAL BUGINEBRING)  Production of light aromatics from a	coal hydrogenates
storage facilities for estimation of stor	age costs		p0680 A80-49631
p0661 Chemical Energy Storage for Solar Thermal E	180-47666	Development of new catalysts for coarse	al liguid
Conversion		[FE-2595-5]	p0710 N80-32569
	A80-48195	CRITICAL PATH BETBOD	
Residential photovoltaic systems costs	A80-48229	General application of the critical resource characterization and plan	
Projected costs for electricity and product		underground coal mining	
OTEC facilities and plantships	A80-48349	[DOE/ET-11268/3] CROP GROWTH	p0707 180-32272
Design, performance and life cycle cost		Production of sugarcane and tropical	l grasses as a
relationships for a 500kW space solar arm		renewahle energy source	-0600 NOA 30E#3
A comparison of capital cost estimates and	A80-48356 process	[ORO-5912-13] CROPS	p0699 N80-30543
efficiencies for hydrogen production by	_	Carbohydrate crops as a renewable re	
thermochemical cycles and water electroly	'S1S A80-48458	fuels production. Volume 3: Juic [BMI-2031-VOL-3]	ce preservation p0696 N80-29511
Screening method for wind energy conversion		CRUCIBLES	pooso 200 25011
	N80-29891	Silicon web process development	-0634 NOO-30668
Solar heating and domestic hot water system installed at Kansas City, Fire Stations,		[NASA-CR-163386] CRUDE OIL	p0631 880-28664
City, Missouri		Processing of coal, oil sand and he	avy oil in situ
[MASA-CR-161513] p0641 Cryogenic methane separation/catalytic	N80-30895	by electric and magnetic fields	p0669 A80-44846
hydrogasification process analysis		Recent activity in U.S. tar sand	-
[PE-3044-T7] p0704  Sconomic evaluation of the MIT process for	N80-31635	Tar sands and heavy oil reservoir e	p0671 A80-48166
manufacture of ethanol		geophysical well logs	
[DSE-3992-T1] p0705 Cogeneration Technology Alternatives Study	N80-31647	Conversion of nitrogen oxide gases	. p0671 A80-48167
Volume 3: Energy conversion system	(CIED, .	particles in oil refinery plumes	
characteristics [NASA-CR-159761] p0748	N80-31869	Impact of olectric care on H C not	p0572 A80-48534
Solar energy system economic evaluation for		Impact of electric cars on U.S. pet: consumption	FOTER
Blcam-Tempe, Tempe, Arizona and Blcam-San	Diego,	[SAE PAPER 800108]	p0773 A80-49726
San Diego, California [NASA-CE-161492] p0644	N80-31872	The potential in Denmark for substi- resources by waste incineration p	
Solar Central Receiver Hybrid Power Systems			p0682 180-49974
sodium-cooled receiver concept. Volume 2 2: Conceptual design, sections 5 and 6	, DOOK	New directions in energy recovery for refinery oily sludges	com berroredm
[DOR/ET-20567/1-2-BK-2] p0645	N80-31897		p0685 A80-50034
Use of solar energy to produce process heat industry	ior	Worldwide survey of current experient residual and crude oils in gas turn	
[SERI/TP-731-626] p0651	N80-32863	[ EPRI-AF-1243 ]	p0693 N80-28724
Oxygen electrodes for energy conversion and [DOE/ET-25502/1] p0753	storage   180-32878	Haterial-flow data structures as a leading of the control of th	basis for
Satellite Power Systems (SPS) cost review	300 320.0	[LBL-10248]	p0760 N80-31923
	n80-32928	The fate and effects of crude oil s	
COST REDUCTION  Low cost composite materials for wind energ	<b>1 y</b>	subarctic permafrost terrain in in [PB80-187305]	p0585 N80-31984
conversion systems	-	Energy and technology review.	_
pown to earth operations centralized	A80-44104	[UCRL-52000-80-6] International energy indicators	p0588 N80-32909
ground-based power distribution systems f	or	[DOB/IA-0010]	p0588 N80-32918
aircraft fuel savings	A80-46681	Potential displacement of petroleum solar energy technologies	imports by
New approach to electrode current collection		[SERI/TR-352-504]	p0656 N80-32959
LiAl/iron sulfide cells	A80-48191	Rnergy policy: Supply and demand a	
Possible means of cutting energy costs and		[GPC-56-541] Incentives for energy conservation	p0591 N80-33870
primary energy in waste water purificatio		[GPO-55-634]	p0591 N80-33871
Silicon solar cell array technology and the	A80-50818	CRYOGREIC EQUIPMENT  Hodal analysis of miniature cryogen:	ic coolers
prospects for cost reduction			p0734 A80-48500
pub28 Design and fabrication of a low cost Darrie	A80-52861 us	CRYOGREIC BAGEETS Experiments on H2-02 MHD power gener	ration
vertical axis wind turbine system, phase	1		p0717 A80-44239
[ALO-4272-T2] p0578 An improved synthesis of 2,4,8,10-tetroxasp	N80-28888 iro	HHD high performance demonstration ( [FE-2895-7]	experiment p0751 N80-32231
(5.5) undecane		CRYOGRAICS	· .
[NASA-CASE-ARC-11243-2] p0583 Investigation of learning and experience cu	180-31472 IIVes	Internally cooled cabled superconductions for applications to fusion reactor	
[SERI/TR-353-459] p0646	N80-31911	generators	·
Low-cost solar array project and Proceeding the 15th Project Integration Secting	s of	Cryogenic methane separation/cataly	p0720 A80-45054
	B80-32852	hydrogasification process analysis	3
•		[FE-3044-16]	p0690 N80-28548

CRISTAL DEFECTS SUBJECT INDEX

	•
The dc superconducting power transmission line	DATA PROCESSIEG
project at LASL: US DOB division of electric	Three computer codes to read, plot and tabulate
energy systems	operational test-site recorded solar data
[LA-8323-PR] p0759 H80-30656	[HASA-TH-78293] p0644 H80-3187
Cryogenic methane separation/catalytic hydrogasification process analysis	DATA PROCESSING EQUIPMENT A multi-site magnetotelluric measurement system
[PB-3044-T7] p0704 B80-31635	with real time data analysis
CRYSTAL DEFECTS	p0714 H80-3398
Some characteristics of low-cost silicon sheet	DATA TRANSMISSION
p0605 180-46756 Thermoelectricity - Phase diagrams and	A study of the applicability/compatibility of inertial energy storage systems to future space
imperfection structures. II	Bissions
p0731 A80-48434	[HASA-CR-163584] p0777 H80-3285
CRISTAL DISLOCATIONS  Research on Cu sub x S/(cd, Zn)S photovoltaic	DEACTIVATION Shift conversion and methanation in coal
solar energy converters	qasification: Bench-scale evaluation of a
[LBL-10791] p0654 H80-32927	sulfur resistant catalyst
CRYSTAL GROWTH	[FE-3240-T4] p0692 N80-2856
Low cost crystalline silicon for solar cells p0600 A80-46703	DECISION BAKING  Haterial-flow data structures as a basis for
Potential for improved silicon ribbon growth	energy information system design
through thermal environment control	[LBL-10248] p0760 N80-3192
p0601 180-46704	DREP SPACE DETWORK
Some characteristics of low-cost silicon sheet p0605 180-46756	Concentrator-enhanced photovoltaic arrays for deep space applications
On the effects of boron and phosphorus primary	p0614 A80-4821
impurities in p-type silicon material for solar	Deep space network energy program
cells p0606 A80-46758	DECRADATION . p0590 H80-3344
Current status of growth processes for solar grade	Materials for fuel cells
silicon	[PB80-182355] p0748 B80-3095
p0620 A80-48789	Metallurgical analysis and high temperature
Silicon web process development [NASA-CR-163386] p0631 H80-28864	degradation of the black chrome selective absorbe [LBL-10293] p0643 N80-3153
CRISTAL STRUCTURE	DEHUMIDIPICATION
Thermoelectricity - Phase diagrams and	A packed bed dehumidifier/regenerator for solar
imperfection structures. II	air conditioning with liquid desicoants p0595 A80-4531
CURRENT DENSITY	An investigation of simultaneous heat and mass
Short circuit current in indium tim oxide/silicon	transfer in subbituminous coal hot gas
solar cells	drying for underground coal conversion
p0622 A80-50752	p0676 A80-4834 DELMARVA PERINSULA (DE-MD-VA)
Cycling characteristics of nickel-hydrogen cells	Use of geothernal energy in the eastern United
p0771 A80-48444	States
Production of light aromatics from coal hydrogenates	p0685 A80-5090 DEHAND (ECONOMICS)
p0680 A80-49631	The effect of demand uncertainty on the relative
CYCLIC LOADS	economics of electrical generation technologies
Testing flat plate photovoltaic modules for	with differing lead times p0570 A80-4633
terrestrial environment p0608 A80-46788	The economics of energy prices - Doubts and
CYCLOTRON PREQUENCY	uncertainty
Parametric excitation of ion quasi-mode by the	p0573 A80-4939
pump near the ion cyclotron frequency plasma heating in tokamaks	The investment demand of energy economy and its financing
p0736 180-49072	p0575 A80-5082
Some perspectives on the use of powerful gyrotrons	The outlook for nuclear power
for the electron-cyclotron plasma heating in large tokamaks	[PB80-175755] p0579 N80-2915 Market penetration of energy supply technologies
p0738 A80-51038	p0579 880-2983
CICLOTROS RADIATION	Documentation of volume 3 of the 1978 Energy
Density profiles in tokamaks from electron	Information Administration annual report to
cyclotron radiation spectra p0738 A80-51018	congress [DOE/BIA/CE-0456] p0782 B80-3286
CEOCHRALSKI METHOD	Energy policy: Supply and demand alternatives
A multiple p-n junction structure obtained from	[GPO-56-541] p0591 HBO-3387
as-grown Czochralski silicon crystals by heat treatment - Application to solar cells	The global 2000 report to the president. Entering
p0595 A80-45121	the twenty-first century. Volume 2: The
	technical report trends in population,
D	climate, gross mational product, earth resources, technology, and man environment
DIES	interactions
Potential for hydropower development at existing	p0782 N80-3229
dams in New England Volume 1: Physical and	DEMORITIC CRISTALS
economic findings and methodology [PB80-169121] p0578 B80-28934	Silicon web process development [BASA-CE-163386] p0631 B80-2886
Potential for hydropower development at existing	DEMITROGRATION
dams in New England. Volume 2: User's manual	Development of unique catalysts for
[PB80-169139] p0578 H80-28935 DATA ACQUISITION	hydrodenitrogenation of coal-derived liquids [FE-3297-1] p0690 B80-2848
Environmental data for sites in the Mational Solar	Development of unique catalysts for
Data Betwork	hydrodenitrogenation of coal-derived liquids
[SOLAB/0010-80/02] p0649 M80-31975	anilines
Coal gasification/gas cleanur test facility: Volume 1. Description and operation	[FE-3297-2] p0690 H80-2854
[PB8G-168378] p0707 880-31990	
	· · · · · · · · · · · · · · · · · · ·

p0690 #80-28545

SUBJECT INDEX DIESEL ENGINES

An investigation of wind loads on solar collectors. Appendix 1: Data listing for top and bottom of collector Development of unique catalysts for hydrodenitrogenation of coal-derived liquids --decahydroquinoline and quinoline p0633 #80-28937 [FB-3297-3] D0690 N80-28546 PB80-158751] Solar space heating for the Visitors Center, Stephens College, Columbia, Missouri DECEMBERATION Applied research and evaluation of process concepts for liquefaction and gasification of [ NASA-CR- 161485 ] p0635 N80-29849 Development of high-temperature turbine subsystem technology to a technology readiness status, western coals [FE-2006-16] p0691 #80-28558 phase 2 [FL-1806-86] p0701 N80-30753 Grad B focusing and deposition of relativistic Design study of a two-phase turbine bottoming cycle
[DOE/ET-15350/T1] p0744 880-30757
Small Wind Turbine Systems 1979: A Workshop on R electron beams p0717 A80-43972 Deposition, fabrication and analysis of polycrystalline silicon MIS solar cells [DOE/ET-23044/4] p065 and D Requirements and Utility Interface/Institutional Issues. [DOE/ET-23044/4] p0653 M80-32920 Electrochemical photovoltaic cells cdSe thin film Volume 1: R and D requirements electrodes [RFP-3014-VOL-1] p0747 N80-30943 Potential of spark ignition engine, effect of wehicle design variables on top speed, [DSE-4042-T16]
DESALIMIZATION D0654 N80-32925 performance, and fuel economy A scheme for large scale desalination of sea water p0586 N80-32736 by solar energy [PB80-191836] p0595 A80-45313 Engineering test facility conceptual design -for magnetohydrodynamic generators DESIGN ANALYSIS A 150 MW power generating gas turbine plant [DOB/FR-2614/3] p0753 #80-32943 p0719 A80-44773 DESCRPTION Operational characteristics of a 60 kW photovoltaic system integrated with a utility grid Recovery of ethanol from fermentation broths using selective sorption-desorption p0609 A80-46797
The design, application benefits, and economics of energy-efficient motors - A technological update p0678 A80-48516 DESTRUCTIVE TESTS High energy density composite flywheel program [AD-A087076] p0777 N80-31892 p0571 A80-47592 Photovoltaic systems design and performance --for commercial applications DESULPURIZIEG Economic performance model of AFBC systems p0611 A80-47597 Atmospheric Fluidized Bed Combustion p0571 A80-48199 Heat-rejection design for large concentrating Application of the lime/limestone flue gas solar arrays p0614 180-48211
Design and flight performance of the Pioneer Venus
Multiprobe and Orbiter solar arrays desulfurization process to smelter gases D0576 A80-53084 Applied research and evaluation of process concepts for liquefaction and gasification of Large area flexible solar array design for Space western coals p0691 #80-28558 Shuttle application [FE-2006-16] p0691 Air Pollution control device configurations p0615 A80-48214 [PB80-193253] DEUTERIUM COMPOUNDS The 1980 technology status of the Dynamic Isotope p0593 #80-33972 Power System D0725 A80-48255 Energy and technology review [UCRL-52000-80-6] Design of 40-HW grazing and moored OTEC p0588 N80-32909 pilot/demonstration plants DEVELOPING NATIONS p0727 A80-48348 The connectial application of an OTEC Jacket Stirling engines for developing countries Stirling engines for developing countries
p0732 A80-48454
Social acceptance of energy systems - Some
observations on the situation in the Third World
p0572 A80-49025
Financing of energy investments - Capital and
policy requirements of developing countries /tower/ design p0728 A80-48350 Further analysis of a novel wave energy device p0728 A80-48352 Design study of a coal-fired thermionic p0573 A80-49395 /THI/-topped power plant p0730 A80-48422 Provision of electric power as a prerequisite and determining factor for safeguarding the industrial community and ensuring the economical Universal thermoelectric design curves --- of heat DUMPS development of the Third World p0731 A80-48435 Thermoelectric OTEC - An update --- design analysis p0731 A80-48436 p0575 A80-50824
The potential role of biofuels within the built Nickel hydrogen battery advanced development environment program status report P0688 A80-53474 D0770 A80-48439 DIAPERAGES Nickel hydrogen battery for a spacecraft power Development of a diaphragm Stirling engine heat-actuated heat pump D0770 A80-48440 D0731 A80-48425 Hickel-hydrogen battery integration study for the Multimission Modular Spacecraft DIBLECTRICS Momentum transfer of laser radiation to p0770 A80-48441 inhomogeneous dielectrics --- Thesis One megawatt /thermal/ bench model solar receiver design and test p0737 A80-50356 DIESEL BEGIERS p0619 A80-48464 A review of advanced vehicular diesel research and Test evaluation of a prototype 18-ton solar powered heating and cooling system development programs which have potential application to stationary diesel power plants [AD-A085601] p0743 880-29738 [AD-A085601] p0743 B80-29734
Design study of a two-phase turbine bottoming cycle
[DOB/BT-15350/T1] p0744 B80-3075 p0619 A80-48480 Services rendered for waste incideration power plants technology and implementation exemplified with the waste incineration heating power plant of the seaport of Bremerhaven p0744 #80-30757 Reduction of fuel consumption by thermodynamic optimization of the Otto motor: Comparative investigation of Otto diesel engines
[EUB-6711-DE] p New reflector design which avoids losses through gaps between tubular absorbers and reflectors p0585 N80-32733 Potential of diesel engine, 1979 summary source for solar collectors document p0625 A80-51678
An investigation of wind loads on solar collectors [PB80-193659] p0585 N80-32734
Potential of diesel engine, emission technology
[PB80-192685] p0586 N80-32735 p0633 N80-28936 FP80-1587441

DIRSEL PUBLS	DAM-ATOLL - A system for extracting energy from
Comparative analysis of the basic combustion	ocean waves
characteristics of some heavy hydrocarbon fuels	p0740 A80-53679 DOBESTIC REERGY
in application to aircraft gas turbine engines p0721 A80-47424	The design of photovoltaic systems for residential
Sulfate in diesel exhaust	applications in the United States
p0575 A80-50528	p0602 A80-46716
Preparation and stability of emulsions of methanol	The Federal Geothermal Energy Program
in automotive diesel oil	p0723 A80-48182
[PB80-169162] p0697 N80-29526	Residential photovoltaic systems
Combustion of drops and sprays of no. 2 diesel oil and its emulsions with water and methanol.	p0615 A80-48228 Residential photovoltaic systems costs
Volume 1: Experimental	p0615 A80-48229
[PB80-178213] p0698 #80-30470	470-k# photovoltaic power system for Saudi Arabia
Combustion of drops and sprays of no. 2 diesel oil	villages
and its emulsions with water and methanol.	p0616 A80-48232
Volume 2: Theoretical [PB80-178221] p0698 M80-30471	Development of a 4 kW wind turbine generator p0725 A80-48269
Autoignition characteristics of aircraft-type fuels	Solar/electric district heating via CASES
[ NA SA-CR-159886 ] p0698 880-30535	Community Annual Storage Energy Systems
Process evaluation: Steam reforming of diesel	p0616 A80-48286
fuel oil	Wind resource assessment in the upper Skagit Biver
[AD-A087053] p0699 N80-30538	Valley of Washington p0675 A80-48319
Performance of a diesel engine operating on raw coal-diesel fuel and solvent refined coal-diesel	Residential photovoltaic flywheel storage system
fuel slurries	performance and cost
[CONS-3288-T6] p0701 N80-30758	p0768 A80-48377
Cogeneration Technology Alternatives Study (CTAS).	An energy and cost analysis of residential heat
Volume 3: Energy conversion system	pumps in northern climates
characteristics	p0571 180-48426
[NASA-CR-159761] p0748 N80-31869 Liquid fuels production from biomass corn and	A comparison of the flat plate and concentrating solar collector
algae	p0619 180-48507
[COC-4388-10] p0708 N80-32545	Life cycle cost analysis in residential buildings
Soot reduction in diesel engines by catalytic	and consumer appliances
effects	p0572 A80-48515
[BNL-27792] p0585 N80-32731	A refuse incineration plant in combination with
Preparation and stability of emulsions of methanol in automobile diesel oil	district heating demonstrated by the Iserlohn Plant
[CSIR-CENG-294] p0713 N80-33579	p0681 A80-49964
DIFFUSE RADIATION	Use of geothermal energy in the eastern United
Total and non-isotropic diffuse insolation on	States
tilted surfaces	p0685 A80-50908
p0599 A80-46571 The effect of direct and diffuse radiations on the	Performance monitoring of low energy house, Macclesfield
thermal performance of flat-plate solar collectors	p0575 A80-50944
p0620 A80-48793	An overview of NASA's participation in the
DIGITAL SIMULATION	nation's energy program
MOD-2 wind turbine farm stability study	p0625 A80-51950
[NASA-CR-165156] p0755 N80-33862 DIMENSIONAL STABILITY	Solar opportunities - Domestic and international p0625 A80-51951
Static investigation of rotor blades at rest and	TIDP - Basic research for answering Plorida's
under quasi-stationary loading	residential energy conservation questions
[ISD-243] p0747 N80-30948	p0576 A80-51954
DIRECT CURRENT	The economic feasibility of passive solar space
D.C. electrical conductivity of Green Biver oil shales	heating systems p0627 A80-52832
p0685 A80-50278	Photovoltaics in the U.S.A A progress report
Open-cycle MHD power conditioning and control	p0629 A80-52866
requirements definition	DOE solar thermal power systems program
[BPRI-AP-1345] p0752 N80-32864	p0629 A80-52869
DIRECT POWER GRHENATORS	DOE view of solar power commercialization and
AC/DC power converter for batteries and fuel cells [EPRI-EN-1286] p0750 N80-31937	applications p0629 A80-52870
Direct electrochemical generation of electricity	U.S. Department of Energy ocean waves and ocean
from coal	currents energy conversion programs - An overview
[SAH-0115-105-1] p0752 N80-32865	p0740 A80-53678
DIRECTIONAL SOLIDIFICATION (CRISTALS)  Low-cost, high-efficiency silicon by heat	Environmental data for sites in the Bational Solar Data Network monitoring performance of solar
exchanger method and fixed abrasive slicing	energy demonstration projects
technique for solar cells	[SOLAB/0010-79/12] p0633 N80-28947
P0600 A80-46700	Characteristics of the housing stock and
DISPOSAL :	
SPS salvage and disposal alternatives	households: Preliminary findings from the
[ NACA = CD= 161588] =0681 NOA=20000	households: Preliminary findings from the National Interim Energy Consumption Survey
[NASA-CE-161548] p0641 N80-30898 DISULPIDES	households: Preliminary findings from the National Interim Energy Consumption Survey p0579 H80-29839
[MASA-CE-161548] p0641 M80-30898 DISULFIDES Scaling up of bipolar lithium/iron disulfide cells	households: Preliminary findings from the National Interim Energy Consumption Survey
DISULPIDES Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193	households: Preliminary findings from the National Interim Energy Consumption Survey p0579 N80-29839 Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman, Georgia
DISULFIDES Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193 Calcium/iron disulfide secondary cells	households: Preliminary findings from the National Interim Energy Consumption Survey p0579 N80-29839  Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman, Georgia [NASA-CR-161494] p0635 N80-29853
DISULFIDES Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193 Calcium/iron disulfide secondary cells p0764 A80-48239	households: Preliminary findings from the National Interim Energy Consumption Survey p0579 H80-29839 Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman, Georgia [HASA-CB-161494] p0635 H80-29853 Solar energy system performance evaluation:
DISULFIDES Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193 Calcium/iron disulfide secondary cells p0764 A80-48239 DIVIEC (UNDERNATER)	households: Preliminary findings from the National Interim Energy Consumption Survey p0579 N80-29839 Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman, Georgia [MASA-CE-161494] p0635 M80-29853 Solar energy system performance evaluation: Seasonal report for Pern Lansing, Lansing,
DISULFIDES Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193 Calcium/iron disulfide secondary cells p0764 A80-48239	households: Preliminary findings from the National Interim Energy Consumption Survey p0579 H80-29839 Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman, Georgia [HASA-CB-161494] p0635 H80-29853 Solar energy system performance evaluation:
DISULFIDES Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193 Calcium/iron disulfide secondary cells p0764 A80-48239 DIVING (UNDERWATER) The use of computer-controlled manipulators in underwater technology [DPVLR-MITT-78-02] p0714 M80-34117	households: Preliminary findings from the National Interim Emergy Consumption Survey p0579 N80-29839  Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman, Georgia [MASA-CB-161494] p0635 N80-29853  Solar energy system performance evaluation: Seasonal report for Fern Lansing, Lansing, Michigan [NASA-CB-161491] p0635 N80-29855  Solar energy system performance evaluation:
DISULFIDES Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193 Calcium/iron disulfide secondary cells p0764 A80-48239  DIVING (UNDERWATER) The use of computer-controlled manipulators in underwater technology [DPVLE-HITT-78-02] DONES (STRUCTURAL FORES)	households: Preliminary findings from the National Interim Emergy Consumption Survey p0579 N80-29839  Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman, Georgia [NASA-CR-161494] p0635 N80-29853  Solar energy system performance evaluation: Seasonal report for Fern Lansing, Lansing, Michigan [NASA-CR-161491] p0635 N80-29855  Solar energy system performance evaluation: Seasonal report for IBM System 1B, Carlsbad, New
DISULFIDES Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193 Calcium/iron disulfide secondary cells p0764 A80-48239  DIVIES (UNDERNATES) The use of computer-controlled manipulators in underwater technology [DPVLR-BITT-78-02] DOMES (STRUCTURAL FORES) Ceramic dome receiver technology developments	households: Preliminary findings from the Bational Interim Emergy Consumption Survey  p0579 H80-29839  Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman, Georgia [HASA-CR-161494]  Solar energy system performance evaluation: Seasonal report for Pern Lansing, Lansing, Michigan [HASA-CR-161491]  Solar energy system performance evaluation: Seasonal report for IBM System 18, Carlsbad, New Mexico
DISULFIDES Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193 Calcium/iron disulfide secondary cells p0764 A80-48239  DIVING (UNDERWATER) The use of computer-controlled manipulators in underwater technology [DPVLE-HITT-78-02] DONES (STRUCTURAL FORES)	households: Preliminary findings from the National Interim Emergy Consumption Survey p0579 N80-29839  Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman, Georgia [MASA-CR-161494] p0635 N80-29853  Solar energy system performance evaluation: Seasonal report for Fern Lansing, Lansing, Michigan [MASA-CR-161491] p0635 N80-29855  Solar energy system performance evaluation: Seasonal report for IBM System 1B, Carlsbad, New

SUBJECT INDEX BCOBORIC ANALYSIS

Solar project description for Sir Galahad Company, single family residence, Virginia Beach, Virginia [SOLAR/1028-79/50] p0646 H80-31920 Energy policy: Supply and demand alternatives [GPO-56-541] p0591 H80-33870 Recent developments in the economic modeling of photovoltaic module manufacturing Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities DOPED CRISTALS p0672 180-48200 The influence of grain size and dopant Potential for biological conversion of biomass to liquid fuels concentration on the electrical properties of polycrystalline silicon films On the effects of boron and phosphorus primary impurities in p-type silicon material for solar The economics of aquifer storage of chilled water for air conditioning p0767 A80-48337 p0606 A80-46758 The economics of compressed air energy storage DRAINAGE with thermal energy storage Trace element characterization of coal wastes p0767 A80-48339 [PB80~166150] P0577 H80-28488 Potential economics of large space based solar DRILLING power stations p0617 A80-48354 Economics of shale oil production by radio frequency heating [UCRL-52942] Process economics and the second law in thermochemical hydrogen production - The effect p0710 N80-32566 DROP SIZE of heat transfer p0663 A80-48459 Comparative economics of small solar thermal model of direct contact heat transfer for latent heat energy storage [SERI/TP-631-567] p0779 N80-32955 electric power systems DURABILITY p0618 A80-48462 Collector sealants and breathing [DOB/CS-15362/1] The economics of energy prices - Doubts and p0650 N80-32527 uncertainty  $$\rm p0573~\lambda80\text{-}49396$$  Bconomic and technical evaluation of the  $\lambda mes$  , DUST COLLECTORS Collecting fly ash from low sulphur coals: An Overview of Australian experience Iowa solid waste recovery system p0592 N80-33932 Increased information acquisition and DYES Structures, reduction potentials and absorption maxima of synthetic dyes of interest in photochemical solar-energy storage studies as a condition for the further development of energy economy structures p0575 A80-50826 p0595 A80-45314 The investment demand of energy economy and its DYNABIC CONTROL financing Dynamics and control of a continuum model for a p0575 A80-50827 Thermodynamic and economic analysis of heat pumps solar power system [AIAA 80-1740] p0757 A80-45534 Dynamic simulation and development of a control strategy for a distributed, concentrating solar for energy recovery in industrial processes [ASME PAPER 78-WA/HT-64] P0686 A80-52049
Relative merits of alternate linking techniques collector field for underground coal gasification and their p0629 A80-53571 · system design implications p0688 A80-52969 DYNAMIC STABILITY MOD-2 wind turbine farm stability study [MASA-CR-165156] p0 Comparison of coal-fired power systems in waste heat applications in Tacoma, Washington [TID-29379] p0693 880-2 p0755 #80-33862 Simplified energy design economics: Principles of economics applied to energy conservation and solar energy investments in buildings
[PB80-179245]
Solar energy exercises DYNAMONETERS Rocky Plats Small Wind Systems Test Center activities. Volume 2: Controlled velocity. vibration and dynamometer testing of Small Wind Energy Conversion Systems [RPP-3004-VOL-2] Solar energy system economic evaluation: IBM System 2, Togus, Maine [HASA-CR-161510] p0635 N8 D0746 N80-30908 p0635 N80-29854 Assessment of integrated urban energy options [PB80-173644] po581 M80-30234
Solar energy system economic evaluation final report for SEMCO-Loxabatchee, Loxabatchee BARTS (PLASET) The benefits of solar power satellites P0598 A80-46387 BARTE ATBOSPHERE National Wildlife refuge, Palm Beach County, Potential use of terrestrial photovoltaics for Plorida future space solar arrays [ NASA-CR-161512 ] Design study and economic assessment of multi-unit offshore wind energy conversion systems application. Volume 1: Executive summary [WASH-2330-78/4-VOL-1] p0746 B80-3093 p0658 N80-33882 RCOLOGY An attempt at balancing the environmental effects of electric power generation with the framework p0746 880-30930 Energy analysis program, PY 1979
[LBL-10320] p0582
Economic evaluation of the MIT process for of the country's economic system p0575 A80-50820
The global 2000 report to the president. Entering the twenty-first century. Volume 2: The technical report --- trends in population, climate gross national angles. p0582 N80-30942 manufacture of ethanol p0705 N80-31647 [DSE-3992-T1] climate, gross national product, earth resources, technology, and man environment interactions Comparison of solar-thermal and fossil total-energy systems for selected industrial applications p0586 B80-32871 p0782 N80-32296 [CRHL/TH-7022] Chemical energy storage for solar thermal conversion [SAND-79-8198] p0652 N80-32889 Economic evaluation of the Annual Cycle Energy RCONONIC ANALYSTS An update of OTEC baseline design costs p0718 480-44604 System (ACBS). Volume 1: Executive summary [OBNL/SUB-7470/1-V1] p0587 M80~32905 Simple economic evaluation and applications Technology and economics of starting materials for low-cost silicon solar cells D0600 A80-46698 A revised economic analysis of photovoltaic power experiments for photovoltaic systems for remote modules sites [SAND-80-0749C] p0602 A80-46715 Photovoltaics commercialization readiness assessment p0655 #80-32937 Optimum systems design with random input and p0607 A80-46772 output applied to solar water heating p0657 N80-33854

•			
ECONONIC DEVELOPMENT		Pollutants from synthetic fuels prod	nction: Coal
Social acceptance of energy systems - S	Some .	gasification screening test result	
. observations on the situation in the		[PB80-182769]	p0707 H80-31986
		BIGENVALUES	_
Provision of electric power as a prerequent		Eigenvalue bounds for Hill's equatio	
determining factor for safeguarding to industrial community and ensuring the		stability theory for magnetohydrod equilibria	yna mic
development of the Third World	e economical	edarripria	p0720 A80-45851
	0575 A80-50824	Destabilization of drift-universal e	
ECOHORIC FACTORS		toroidal effects	
Economic requirements for new materials		•	p0736 A80-49209
photovoltaic cells		BJECTORS	
	0596 A80-45317	Estimated performance of an electroh	
Energy choices for the 1980s	0570 A80-47099	power generator which utilizes a t [AIAA PAPER 80-1341]	p0717 A80-44126
. The design, application benefits, and e		LAIAA PAPEE 8U-1341] . BLECTRIC AUTOBOBILES	p0.11. 200 44120
energy-efficient motors - A technolog		The case for fuel-cell-powered vehic	les
	571 A80-47592		p0721 A80-47100
Steps to system analysis in waste manag		Electric vehicles - Finally a realit	
	)574 A80-49932		p0762 A80-48125
The usefulness of 'alternative' energy	sources	An analysis of aluminum-air battery	propulsion
from the economic and energetic point		systems for passenger vehicles	-0774 100 50574
The technical and economic aspects of b	0685 A80-50823	Lead-acid traction batteries for ele	P0771 A80-48471
refinement	Juli coal	vehicle propulsion Directions for	
	0686 A80-51498	development	research and
Energy economic projections for the 197			p0772 A80-48766
	578 N80-28918	Impact of electric cars on national	
Aerospace technology transfer		consumption	
	)579 N80-29210	[SAB PAPER 800111]	p0573 A80-49728
The direct use of coal. Volume 2, part	: A:	Regenerative flywheel energy storage	
Working papers, appendices 1-4	1607 HON-20520	[OCRL-13982-REV-1]	p0775 #80-28884 ·
[PB80-184518] p0 Capital formation for small wind energy	0697 N80-29520	Puel cells for electric utility and applications	cransportation
system manufacturers: A quide to met		[BNL-27452]	p0747 B80-30937
sources		Study of hydrogen-powered versus bat	
[SEBI/TR-98298-1] p0	751 N80-32462	automobiles .	
Economics of shale oil production by ra	dio	[ATR-79 (7759) - 1-VOL-1]	p0665 N80-31271
frequency heating		Small passenger car transmission tes	t: Chevrolet
	710 N80-32566	LOV transmission	
Synthetic fuels from US oil shales: A		[NASA-CR-159882]	p0584 N80-31796
and economic verification of the HYTO	7 10 N80-32567	Comparative analysis of aluminum-air	
[DOB/ET-14102/3] p0 Use of solar energy to produce process		propulsion systems for passenger v [UCRL-52933]	p0778 N80-32907
industry	near rot	Analysis of aluminum-air battery pro	
	0651 N80-32863	systems for passenger vehicles	F
Documentation of volume 3 of the 1978 H	nergy	[ UCRL-83824 ]	p0778 N80-32940
Information Administration annual rep	ort to 1	ELECTRIC BATTERIES	
congress		Batteries for solar electricity	
	782 N80-32869	D	p0605 A80-46747
Costing methodologies for energy system [BNL-27603] po	15 1778 180-32900	Design and performance of the Intern	ational
Potential for supplying solar thermal e		Sun-Earth Explorer power systems	p0765 A80-48307
industrial unit operations		Electrical power subsystem for INSAT	
	588 N80-32911	· · · · · · · · · · · · · · · · · · ·	p0616 A80-48308
District heating and cooling systems fo	r	Electrical power system for the SBS	communication
communities through power plant retro	fit	satellite	
distribution network, volume 4			p0617 A80-48309
[COO-4977/1-VOL-4] p0 ECONOMIC IMPACT	753 N80-32942	An advanced technology iron-nickel b	attery for
The effect of demand uncertainty on the	relative	electric vehicle propulsion	p0766 A80-48327
economics of electrical generation te		Fuel cell systems for vehicular appl	
with differing lead times		[SAE PAPER 800059]	p0736 A80-49720
p0	570 A80-46336	Analysis of the infrastructure for re	
Technical and economic feasibility of a		electric vehicles	
fuel use in process heaters and small		[SAE PAPER 800112]	p0773 A80-49729
	693 H80-28570	Development of advanced batteries at	Argonne
BCOSYSTEMS Proceedings of the Clemson Workshop on		Hational Laboratory [ANL-80-32]	p0776 N80-30927
Environmental Impacts of Pumped Stora	ae	Performance data for a lithium-silic	
Hydroelectric Operations		disulfide, long-life, primary ther	
	588 N80-32964	[SAND-79-2148C]	p0746 880-30933
EDDY CURRETS		AC/DC power converter for batteries	
Processing of coal, oil sand and heavy	oil in situ	[EPRI-EM-1286]	p0750 N80-31937
by electric and magnetic fields		Development of the zinc-chloride bat	tery for
	1669 A80-44646	utility applications	-0770 200 30047
EPPICIENCY Project Project Project Project office	iency	[BPRI-EM-1417]	p0778 N80-32917
Environmental assessment. Energy effic standards for consumer products	Tene l	Analysis of aluminum-air battery pro systems for passenger vehicles	hareton
	589 B80-32988	[UCRL-83824]	p0778 880-32940
REFLORETS		Lithium batteries. Citations from t	
Determination of air pollutant emission	factors	base	
for thermal tertiary oil recovery ope		[PB80-812399]	p0779 N80-32967
California, volume 1	FOF WOO 24224	Lithium batteries. Citations from t	he Engineering
	585 N80-31982	Index data base	-0770 800 2007
Determination of air pollutant emission		[PB80-812407]	p0779 B80-32968
for thermal tertiary oil recovery ope California. Volume 2: Appendix	LACTORS. IN	Assessment of environmental control	recumorogies
	585 N80-31983	for energy storage systems, 1979 [LA-8308-HS]	p0588 N80-32973

Toroidal cell and battery --- energy storage for orbital space applications or power cells for electric vehicles [ NASA-CASE-LEW- 12918-1] D0780 N80-33857 Evaluation of cranking characteristics of commercially available batteries between room temperature and -40 C [AD-A080614] p0780 N80-33906 ELECTRIC CHARGE Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729 BLECTRIC CONTACTS A proposed slotted mask for direct deposition of metal contact pattern on MIS solar cells Linear constraints aid selection of battery charge control parameters --- for orbiting spacecraft power supplies p0769 A80-48400 BLECTRIC CURRENT BBIC and capacitance measurements on Cu25-CdS solar cells - Stability problems --- Electron Beam Induced Current p0603 A80-46725 The lithium-sulfuryl chloride battery - Discharge behaviour p0772 A80-48770 ELECTRIC DISCHARGES CT-6 tokamak research, II - Experimental results p0721 A80-46670 The lithium-sulfuryl chloride battery - Discharge hehaviour D0772 A80-48770 BLECTRIC BEERGY STORAGE Large-scale electrical energy storage p0761 A80-44241 Sodium-sulfur load leveling battery system polyd 480-48235
Volume optimization of sodium-sulfur batteries using various advanced cell conceptsp0764 A80-48236
Analysis of small, nonconventional electric power
systems for remote site applications Status of electrochemical energy storage systems for electric vehicle, solar, and electric utility applications p0765 A80-48325 Low maintenance lead-acid batteries for energy p0765 A80-48326 Nickel hydrogen battery for load leveling application p0766 A80-48328 Sandia battery program for energy storage in photovoltaic systems p0767 A80-48368 Development of a bipolar Zn/Br2 battery p0767 A80-48369
Improvement and scale-up of the NASA Redox storage P0767 A80-48370 The Intelsat V nickel- cadmium battery system p0769 A80-48395 Nickel-cadmium batteries for the Modular Power Subsystem --- of Multimission Modular Spacecraft p0769 A80-48398 Test data analysis and application of nickel hydrogen cells p0771 A80-48446 Nickel-zinc batteries for aircraft and aerospace applications p0772 A80-48483 New separator materials for mickel-cadmium aircraft batteries p0772 A80-48484 Planning for electric utility solar applications: The effects on reliability and production cost estimates of the variability in demand [SERI/TF-351-545] p0587 N80-32 D0587 N80-32888 ELECTRIC GENERATORS Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector [AIAN PAPES 80-1341] p0717 180-44126 Large-scale electrical energy storage p0761 A80-44241

Modelling the competitiveness of first generation connectial OTEC power plants p0718 A80-44605 Analysis, design and realization of a 5 kW photovoltaic generator p0605 A80-46745 Solar-powered Rankine engine assists air conditioning systems with electrical generating capability p0611 A80-47596 Solar ponds for district heating and electricity p0618 A80-48367 Demonstration of heat to electrical energy conversion with a ferroelectric material p0729 A80-48386 Analysis of the application of thermogalvanic cells to the conversion of low grade heat to electricity p0729 A80-48390 A simulation model for wind electric systems p0734 A80-48522 Performance characteristics of a commercially available, point-focus, solar power system p0629 A80-53570 Environmental data energy technology characterizations: Coal [DOE/EV-0074] p0577 N80-28882 Ceramics for turbine engine applications [AGARD-CP-276] p07 [AGRD-CP-276] p0743 N80-29342 A review of advanced vehicular diesel research and a review of advanced venicular qiesel research and development programs which have potential application to stationary diesel power plants [AD-A085601] p0743 N80-29738 Design of a photovoltaic system for a southwest all-electric residence [SAND-79-7056] p0637 N80-29876 Upgrading of coal liquids for use as power generation fuels [ EPRI-AF-1225] p0699 ¥80-30547 Advanced coal gasification system for electric power generation [FE-1514-101] p0703 N80-31634
Cogeneration Technology Alternatives Study (CTAS).
Volume 3: Rnergy conversion system
characteristics [ NASA-CR-159761] p0748 N80-31869 Wind power. Citations from the HTIS data base [PB80-811458] p0751 H80 p0751 M80-31965
Advanced coal gasification system for electric
power generation [PE-1514-113] p0709 N80-32557 Design and development of Stirling engines for stationary power generation applications in the 500 to 3000 horsepower range [DOE/BT-15207/T1] p0752 N80-3272 Combined cycle solar central receiver hybrid power p0752 N80-32723 system study. Volume 1: Executive summary [DOE/ET-21050/1-1] p0586 N8 p0586 N80-32867 Combined cycle solar central receiver hybrid power system study, volume 2 [DOE/ET-21050/1-21 p0586 N80-32868 Oversight: Wind energy program [GPO-51-382]
ELECTRIC HYDRID VEHICLES D0591 N80-33672 Design considerations for a near-term hybrid vehicle p0571 A80-48420 Regenerative flywheel energy storage system [UCRL-13982-REV-1] p0775
Hybrid vehicle potential assessment. Volum p0775 N80-28884 Volume 3: Parallel systems
[CONS-4209-T1-VOL-3]
Electric and hybrid vehicle system research and development project: Hybrid vehicle potential assessment. Volume 1: Summary p0776 N80-31270 [CONS-4209-T1-VOL-1] p0583 N80-: Electric and hybrid vehicle system research and p0583 N80-31272 Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 4: Series systems [CONS-4209-T1-VOL-4] p0748 N80-31273 Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] p0583 N80-31274 Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation --- impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] p0583 N80-31275 ELECTRIC IGNITION SUBJECT INDEX

Small passenger car transmission test; Chevrolet	RLECTRIC POTESTIAL
LOV transmission [BASA-CR-159882] . p0584 B80-31796	Interface recombination and junction field studies in the Cu2S-CdS solar cell
Design study of steel V-Belt CVI for electric	p0603 A80-4672
Vehicles [NASA-CR-159845] p0777 N80-32299	Open-circuit voltage of induced-junction solar cell p0622 A80-5075
RECTRIC IGHTION	Study of power management technology for orbital
Neutral-beam energy and power requirements for	multi-100kWe applications. Volume 3:
expanding-radius and full-bore start-up of tokamak reactors	Requirements {
p07 19 A80-44656	MBD high performance demonstration experiment
ILECTRIC MOTOR VEHICLES The case for fuel-cell-powered vehicles	[PE-2895-7] p0751 B80-3223 RLECTRIC POWER
p0721 180-47100	Autonomous solar-electric systems
Electric vehicles - Finally a reality	p0596 A80-4547
p0762 A80-48125 Optimization studies of lithium/iron sulfide cells	The effect of demand uncertainty on the relative economics of electrical generation technologies
for electric vehicle applications	with differing lead times
p0763 A80-48190 Wind energy for electric vehicle recharge	p0570 A80-4633 Satellite power systems for Western Europe -
p0726 180-48273	Problems and solution proposals
Status of electrochemical energy storage systems	p0622 A80-5063
for electric vehicle, solar, and electric utility applications	Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels
p0765 A80-48325	p0738 A80-5094
An advanced technology iron-nickel battery for electric vehicle propulsion	Status of the satellite power system concept development and evaluation program
p0766 A80-48327	p0623 A80-5095
Development of a bipolar Zn/Br2 battery p0767 A80-48369	Rockwell Satellite Power System /SPS/ concept
Performance and structural characteristics of the	definition studies p0623 A80-5095.
iron-air battery system for electric vehicle	The first realistic solar energy project
propulsion p0767 A80-48371	p0758 A80-5099 The potential and economics of wind energy - An
Development of a lithium-water-air primary battery	investigation commissioned by the International
for automotive propulsion p0768 A80-48372	Energy Agency for the Pederal Republic of Germany p0689 A80-5407
The aluminum-air battery for electric vehicle	Comparative analysis of net energy balance for
propulsion p0768 A80-48373	Satellite Power Systems (SPS) and other energy
The new age of high performance kinetic energy	systems [DOE/EE-0056] p0582 N80-3091
storage systems	Rnergy analysis of geothermal-electric systems
p0768 A80-48374 Lead-acid traction batteries for electric road	[COO-5085-4] p0584 880-3191 RECTRIC POWER PLANTS
vehicle propulsion Directions for research and	Parametric study of prospective early commercial
development p0772 180-48766	OCHHD power plants /PSPEC/ p0717 A80-4410
System design of The Electric Test Vehicle - One	Results from study of potential early commercial
/ETV-1/ [SAE PAPER 800057] p0772 A80-49718	BHD power plants and from recent ETF design work Engineering Test Facility
Trade-off results and preliminary designs of	p0717 A80-4410
Near-Term Hybrid Vebicles [SAE PAPER 800064] p0772 A80-49723	Closed cycle MBD power plant and retrofit
Impact of electric cars on U.S. petroleum	optimization application p0717 A80-4423
consumption	Experiments on H2-O2 HHD power generation
[SAE PAPER 800108] p0773 A80-49726 Efficiency of coal use, electricity for EVs versus	p0717 A80-4423 Large-scale electrical energy storage
synfuels for ICEs	p0761 A80-4424
[SAR PAPER 800109] p0680 A80-49727 Analysis of the infrastructure for recharging	Ocean thermal energy conversion - A general introduction
electric Vehicles	p0718 A80-4459
[SAE PAPER 800112] p0773 A80-49729 Vehicles testing of near-term batteries	Westinghouse OTEC power systems
[SAE PAPER 800201] P0773 A80-49730	An update of CTEC baseline design costs
'Biberonnage' makes an electric car practical with existing batteries recharging during periods	p0718 180-4460 Modelling the competitiveness of first generation
of non-use	connercial OTEC power plants
[SAE PAPER 800204] p0773 A80-49731	p0718 &80-4460
Automotive absorption air conditioner utilizing solar and motor waste heat	Introducing OTEC to mainland utilities p0719 A80-4460
[HASA-CASE-BPO-15183] p0634 H80-29843	A 150 MW power generating gas turbine plant
Aluminum air battery for electric vehicle propulsion [UCBL-84443] p0779 880-32941	p0719 A80-4477 Pactors influencing the release of boron from coal
Toroidal cell and tattery energy storage for	ash materials
orbital space applications or power cells for electric vehicles	p0570 A80-4548 Computer aided optimal design of compressed air
[NASA-CASE-LEW-12918-1] p0780 N80-33857	energy storage systems
Lead latteries. Citations from the HTIS data base	` p0761` 180-4582
[PB80-813363] p0780 M80-33923 Lead batteries. Citations from the Engineering	A study of the gaseous and particulate pollutants in the environment of a thermal power plant
Index data base	project area
[PB80-813371] p0780 880-33924 LECTRIC HOTORS	p0570 A80-4615 Integration of photovoltaic generation into a
The design, application benefits, and economics of	large generating system
energy-efficient motors - A technological update p0571 A80-47592	p0604 A80-4674.  Do to ac power conditioning for photovoltaic
Feet For Ailin	arrays and utility interfacing
	-06AE 10A-167h

Engineering studies on the optimization of the collection subsystem of A I NW photovoltaic facility p0609 A80-46794 A synergistic solid waste to energy project -Phase 1 project concept p0570 A80-47586 Energy from MSW - The industrial market Municipal Solid Waste p0670 A80-47588 Municipal solid waste as an industrial fuel p0670 A80-47589 Photovoltaic systems design and performance for commercial applications

p0611 A80-47597 LNG cold, an unutilized energy potential --Liquid Natural Gas for electric power plants
p0671 A80-47776
A new method of efficient heat transfer and

storage at very high temperatures D0762 A80-48180 Open-cycle MHD generator channel development p0723 A80-48185

Development of steam generator components for open-cycle MHD

D0723 A80-48186 Component Development and Integration Facility - A description and status report --- on coal-fired open cycle MHD plant

p0723 A80-48187 Chemical Energy Storage for Solar Thermal Electric Conversion

p0763 A80-48195 Economic analysis of coal burning fluidized bed steam and by-product power generation systems for industrial facilities

p0672 A80-48200 Photovoltaic central station applications - Status and prospects

p0615 A80-48231 A plant The HTGR-GT closed-cycle gas turbine concept with inherent cogeneration /power plus heat production/ capability

p0724 A80-48248 Development of molten carbonate fuel cells for power generation

p0726 A80-48279 Development of a high temperature solid electrolyte fuel cell

p0726 A80-48281

Improved alkaline hydrogen/air fuel cells for transportation applications p0726 A80-48282

Solar/electric district heating via CASES Community Annual Storage Energy Systems p0616 A80-48286

Design of the HTGR for process heat applications p0758 A80-48313 Raft River 5-MW/e/ geothernal pilot plant

p0727 A80-48314 Blectric power generation using low temperature geothermal resources and wood residues

p0675 A80-48315
Hawaii Geothermal Project 'A' wellhead generator feasibility project

The challenge of financing geothermal development p0727 A80-48317

Development of a compressed air energy storage power generation plant - The PBPCO demonstration plant study

p0767 A80-48338 Review of mini-OTEC performance

p0727 A80-48347 Design of 40-HW grazing and moored OTEC pilot/demonstration plants

p0727 A80-48348 Projected costs for electricity and products from OTEC facilities and plantships

p0728 A80-48349 The commercial application of an OTEC Jacket /tower/ design

p0728 A80-48350 The SPS concept - An overview of status and outlook - Satellite Power System p0617 A80-48353

Overview of high efficiency power cycles for fusion p0728 A80-48358 Advanced power technology for fusion reactors p0728 A80-48359 Direct energy conversion for fusion

p0729 A80-48361 Salton Sea solar pond project

p0617 180-48362 Key questions in the application of

salt-stratified solar ponds p0617 A80-48364 Coal-fired fluid bed combustion augmented

compressed air energy storage systems P0768 A80-48376 Comparative economics of small solar thermal

electric power systems p0618 A80-48462

Assessment of solar thermal concepts for small power systems applications

Power processing and control requirements of dispersed solar thermal electric generation systems

Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost

p0573 A80-49648 The combined firing of coal and waste derived fuel in steam raising plant

p0681 A80-49956 Co-combustion trials of pretreated solid urban refuse, on a brown coal-fired boiler

p0681 A80-49957
Waste handling Bijnmond - Energy production of a
large-scale waste incineration plant

Combined production of electrical energy and heat in municipal refuse incinerators in the greater

p0682 A80-49965 Kiener pyrolysis, a link between waste disposal and energy supply

p0682 A80-49983 Materials-related design issues in the solar central receiver pilot plant

p0623 A80-50800 An attempt at balancing the environmental effects

of electric power generation with the framework of the country's economic system p0575 A80-50820

Ocean thermal energy conversion contribution to the energy needs of the United States p0737 A80-50909

On the selection of working fluids for OTEC power

p0738. A80-50946 Alternative configurations for sodium-cooled solar thermal power plants

p0625 A80-52075 Closed-cycle gas turbines for power generation and LNG vaporization

p0739 A80-52600 DOE solar thermal power systems program p0629 A80-52869

Mini-OTEC p0740 A80-53473

Pluid selection for a 100 MW/e/ line focus solar central power station

· p0630 A80-53572 Tidal energy in the Bay of Fundy

p0688 A80-53680 Development of high-temperature turbine subsystem technology to a technology readiness status, [FE-1806-67] p0693 N80-28726

Comparison of coal-fired power systems in waste heat applications in Tacoma, Washington [TID-29379] p0693 N80-28858

parametric study of 1000 NWe combined closed cycle MHD/system electrical power generating plants

THE-78-E-91] p0742 N80-289
The long-term effects of trace elements emitted by energy conversion of lignite coal [PB80-168867] p0578 N80-289 p0742 N80-28931

p0578 N80-28958 The long-term effects of trace elements emitted by energy conversion of lignite coal. Technical appendices Volume 2: [ PB80-168875] p0579 N80-28960

	direct o			olume 2, j	part A:		
	forking pa		appendic	es 1-4			
	PB 80-1845		1 "			B80-29520	
TRE	direct of orking particular parti	nore	coar. v	orume 2, 1	part C:		
i	PB 80-1845	341	аррепитс	es IV-14	D0697	B80-29522	
	ceview of		ed vehic	ular diese			
ć	ievelopmen	t prog	rans whi	ch have o	otential		
ā	applicatio	n to s	tationar	y diesel	boaer by	ants .	
- (	AD-408260	ra j			P0743	NRO- 53 138	
	porteur r NASA-TH-8		THD eT	ectric po	rer bran	180-29862	
	eliminary		ativo as	sessment (			
	the Satell						
	electric e						
	NA SA-CR-1			_		<b>880-29886</b>	
	generation						
	Tolume 6:					iired	
	locogenera NASA-CR-1	5977A-	rocess D	citer, sec		N80-30888	
	generation			ternative:			
ī	olume 6:	Conpu	ter data	. Part 1:	Coal-	fired	
1	ocogenera	tion p	rocess b		ction B		
_·[	NA SA-CR-1	59770-	PI-1-B]			N80-30889	
Cog	eneration Jolune 6:	Techn	ology Al	ternatives	s Study	(CTAS).	
1	rozume o: Rocidual-f	ired n	ter data	. Part 2:	: roce hoi	ler	
	Residual-1   NASA-CR-1			acton pro	D0745	N80-30890	
Nav	y-New Bar	pshire	wind en	eray progr	cam		
(	AD-108650	[6]			p0701	<b>80-30904</b>	
	lity view		olar the	rmal cent:	ral rece	ivers	
	SAND-80-8					N80-30911	
	parative						
	issues ass System (SP						
i	DOE/ER-00	551	arcerna	cive recui		N80-30915	
	parative		is of ne	t energy l			
	Satellite						
5	systems						
	DOE/ER-00					180-30916	
	ne toh ydro					hace	
	generation PB80-8108		ations I	rom the m		N80-30954	
	generation		ology Al	ternatives			
	otame 1:	Indus	trial pr		<b>-</b>	•	
ι	NASA-CR-1	59767]	trial pr	ocesses	p0749	N80-31870	
So <sup>2</sup>	NASA-CR-1 lar Centra	59767] 1 Rece	iver Hyb	ocesses rid Power	p0749 Systems	N80-31870	
So]	NASA-CR-1 lar Centra sodium-coc	59767]  1 Rece  led re	iver Hyb ceiver c	ocesses rid Power oncept. '	p0749 Systems Volume 2	N80-31870	
So] 5	NASA-CR-1 lar Centra sodium-coc l: Concep	59767]    Rece  led re  tual d	iver Hyb ceiver c esign, s	ocesses rid Power	p0749 Systems Volume 2 through	B80-31870	
50] \$ 1	NASA-CR-1 lar Centra sodium-coc l: Concer DOB/ET-20	59767]  l Rece  led rece  tual de  567/1-	iver Hyb ceiver c esign, s 2-BK-1]	ocesses rid Power oncept. ' ections 1	p0749 Systems Volume 2 through p0645	N80-31870 , book 4 880-31896	
50] 50] 1 50]	NASA-CR-1 lar Centra sodium-coo l: Concer DOB/ET-20 lar Centra sodium-coo	59767] I Bece led rectual description 1567/1- I Bece led rectual rectual	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c	ocesses rid Power oncept. ' ections 1 rid Power	p0749 Systems Volume 2 through p0645 Systems Volume 2	#80-31870 , book 4 #80-31896	
Sol	NASA-CR-1 lar Centra sodium-coo l: Concer DOB/ET-20 lar Centra sodium-coo	59767] I Bece led rectual description 1567/1- I Bece led rectual rectual	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c	ocesses rid Power oncept. ' ections 1 rid Power	p0749 Systems Volume 2 through p0645 Systems Volume 2 and 6	880-31870 , book 4 880-31896	
Sol	NASA-CR-1 Lar Centra sodium-coc l: Concep DOB/ET-20 Lar Centra sodium-coc 2: Concep DOE/ET-20	159767] 1 Rece bled re- btual de 1567/1- 1 Rece bled re- btual de 1567/1-	iver Hyb. ceiver c esign, s 2-BK-1] iver Hyb. ceiver c esign, s 2-BK-2]	ocesses rid Power oncept. ' ections 1 rid Power	p0749 Systems Volume 2 through p0645 Systems Volume 2 and 6	#80-31870 , book 4 #80-31896	•
Sol	NASA-CR-1 lar Centra sodium-coc l: Concep DOB/RT-20 lar Centra sodium-coc 2: Concep DOE/RT-20 asibility	159767] I Rece led re led re l567/1- I Rece led re ltual d l567/1- study:	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c	ccesses rid Power oncept. ' ections 1 rid Power oncept. ' ections 5 ell cogene	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 and 6 p0645 eration	880-31870 , book 880-31896 , book 880-31897 in a	
Sol	NASA-CR-1 lar Centra sodium-coc l: Concep DOB/RT-20 lar Centra sodium-coc 2: Concep DOE/RT-20 asibility vater poll	59767] I Rece led re led re local d local led re led re led re led re local study: ution	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control	ccesses rid Power oncept. ' ections 1 rid Power oncept. ' ections 5 ell cogene	p0749 Systems through p0645 Systems volume 2 and 6 p0645 eration	#80-31870 , book #86-31896 , book #80-31897 in a	•
Sol	BASA-CR-1 lar Centra sodium-coc l: Concep DOB/ET-20 lar Centra codium-coc l: Concep DOE/ET-20 sibility vater poll DOB/ET-12	59767] I Bece led receitual de 1567/1- Il Bece led receitual de 1567/1- study: ution 6 1431/T1	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control	ocesses rid Power oncept. v ections 1 rid Power oncept. v ections 5 ell cogene facility,	p0749 Systems folume 2 through p0645 Systems folume 2 and 6 p0645 eration volume p0749	#80-31870 , book #80-31896 , book #80-31897 in a 1 #80-31922	•
Sol	EASA-CE-1 ar Centra sodium-coc i: Concep DOB/ET-20 ar Centra sodium-coc i: Concep DOE/ET-20 sibility sater poll DOB/ET-12 relopment	59767]  Rece  led rece  tual d  567/1-  study:  ution  431/T1  of aol	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control	ocesses rid Power oncept. v ections 1 rid Power oncept. v ections 5 ell cogene facility,	p0749 Systems folume 2 through p0645 Systems folume 2 and 6 p0645 eration volume p0749	#80-31870 , book #80-31896 , book #80-31897 in a 1 #80-31922	•
Sol	INASA-CR-1 lar Centra sodium-coo l: Concep DOB/ET-26 lar Centra sodium-coo l: Concep DOB/ET-20 sibility water poll DOB/ET-12 welopment tech	159767] I Rece led red	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control	ocesses rid Power oncept. v ections 1 rid Power oncept. v ections 5 ell cogene facility,	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 and 6 p0645 eration volume p0749 1 cell 1	N80-31870 , book 4 860-31896 , book 180-31897 in a 180-31922 ower	•
Sol	EASA-CE-1 ar Centra sodium-coc i: Concep DOB/ET-20 ar Centra sodium-coc i: Concep DOE/ET-20 sibility sater poll DOB/ET-12 relopment	159767] I Rece bled rece tual d 1567/1- I Rece led rece tual d 1567/1- study: ution 431/T1 of aol unology 4440/1]	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -VOL-1] ten carb	rid Power oncept. Vections 1 rid Power oncept. Vections 5 ell cogene facility, onate fuel	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 and 6 p0645 eration Yolume p0749 1 cell 1	N80-31870 , book 480-31896 , book N80-31897 in a 1 N80-31922 ower N80-31938	•
Sol	INAS-CR-1 iar Centra sodium-cod : Concep DOB/ET-26 car Centra sodium-cod : Concep DOB/ET-20 sibility vater poll DOB/ET-15 clopment clant tech DOB/ET-15 sivation of systems.	59767] 1 Rece 1 Led re tual d. 567/1- 1 Rece 1 tual d. 567/1- stual d. 567/1- study: 431/71: of mol mology 440/1] f line Volume	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -VOL-1] ten carb	ocesses rid Power oncept. ' ections 1 rid Power oncept. ' ections 5 ell cogene facility, onate fuel cutive sur	p0749 Systems folume 2 through p0645 Systems folume 2 and 6 p0645 eration wolume p0749 cell g p0750 cal powers	N80-31870 , book 480-31896 , book N80-31897 in a 1 N80-31922 ower N80-31938	•
Solution (Solution (Soluti	.BASA-CR-1 Lar Centra sodium-cod lar Concep .Concep .c	59767] 1 Rece tled rece tual d 567/1- 1 Rece tled rece tual d 567/1- study: ution 431/T1 on logy 440/1] f line volume 73-03)	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control ten carb focus s 1: Exe -1-VOL-1	rid Power oncept. Yections 1 rid Power oncept. Yections 5 ell cogene facility, onate fuel colar centive sur ]	p0749 Systems Folume 2 through p0645 Systems Folume 6 and 6 p0645 sration volume p0749 1 cell 1 p0750 cal powen mary p0648	M80-31870 , book 480-31896 , book M80-31897 in a 1 M80-31922 ower M80-31938 r	•
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 Lar Centra codium-cod I: Concer Lar Centra codium-cod I: Concer Lar Centra codium-cod I: Concer Local Lar Centra Concer Local Lar Centra	59767] 1 Rece thal defect that defect that defect the defect that defect that defect that defect the defect that d	iver Hybroceiver coesign, so 2-BK-1] iver Hybroceiver coesign, so 2-BK-2] fuel controlvol-1] ten carb focus so 1: Executiver hybroceiver coesign.	rid Power oncept. 'ections 1 rid Power oncept. 'ections 5 ell cogene facility, onate fuel cutive sur 1 rid power rid power rid power rid power oncepts of the cutive sur 1 rid power rid power oncepts of the cutive sur 1 rid power rid power roccepts on the cutive sur 1 rid power rid power roccepts on the cutive sur 1 rid power rid power roccepts on the cutive sur 1 rid	p0749 Systems Folume 2 through p0645 Systems Folume 2 and 6 p0645 Bration Volume p0749 cell p p0750 ral powe mary p0648	#80-31870 , book #80-31896 , book #80-31897 in a 180-31922 ower #80-31938 r	•
Sol	INAN-CR-1 iar Centra sodium-cod : Concer DOB/ET-20 car Centra sodium-cod : Concer DOB/ET-20 InoB/ET-20 InoB/ET-20 InoB/ET-20 InoB/ET-10 InoB/ET	59767] I Bece led re-	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control: -VOL-1] ten carb  focus s 1: Exe1-VOL-1 iver hyb ceiver c	rid Power oncept. 'ections 1 rid Power oncept. 'ections 5 ell cogene facility, onate fuel cutive sur 1 rid power rid power rid power rid power oncepts of the cutive sur 1 rid power rid power oncepts of the cutive sur 1 rid power rid power roccepts on the cutive sur 1 rid power rid power roccepts on the cutive sur 1 rid power rid power roccepts on the cutive sur 1 rid	p0749 Systems Folume 2 through p0645 Systems Folume 2 and 6 p0645 Bration Volume p0749 cell p p0750 ral powe mary p0648	#80-31870 , book #80-31896 , book #80-31897 in a 180-31922 ower #80-31938 r	•
Sold Sold Sold Sold Sold Sold Sold Sold	INASA-CR-1 Lar Centra sodium-cod Lar Concep DOB/ET-20 Siz Concep Concep Concep DOE/ET-20 Sibility Mater poll DOB/ET-12 Polopment tech DOE/ET-15 Luation of Systems- ATR-60 (77 Lar centra Sodium-cod Szeccntive	59767] I Recelled received description I Recelled received de received description to the received description I received received received received received description  5507,1-  50	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -vOL-1] ten carb focus s 1: Exe -1-vOL-1 iver hyb ceiver c	rid Power oncept. 'ections 1 rid Power oncept. 'ections 5 ell cogene facility, onate fuel cutive sur 1 rid power rid power rid power rid power oncepts of the cutive sur 1 rid power rid power oncepts of the cutive sur 1 rid power rid power roccepts on the cutive sur 1 rid power rid power roccepts on the cutive sur 1 rid power rid power roccepts on the cutive sur 1 rid	p0749 Systems Folume 2 through p0645 Systems Folume 2 and 6 and 6 p0645 ration volume p0749 cell 1 p0750 cal powe mary p0648 systems Folume 2	M80-31870 , book 480-31896 , book M80-31897 in a 1 M80-31922 ower M80-31938 r M80-31943	•
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 Lar Centra sodium-cod II Concep Lar Centra sodium-cod II Concep Lar Centra sodium-cod II Concep Sodium-cod II Concep Sodium-cod II Concep Sodium-cod II Concep II Conc	59767] I Rece lled received de	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -VOL-1] ten carb focus s 1: Exe1-VOL-1 iver hyb ceiver c y 1]	rid Power oncept. Vections 1 rid Power oncept. Vections 5 ell cogenefacility, onate fuel colar centrative surjections 1	p0749 Systems folume 2 through p0645 Systems folume 6 p0645 eration volume p0749 cell r p0750 cal powe mmary p0648 systems p0648	#80-31870 , book #80-31896 , book #80-31897 in a 180-31922 ower #80-31938 r	•
Soll Soll Soll Soll Soll Soll Soll Soll	INASA-CR-1 Lar Centra sodium-cod lar Concep Lar Concep Lar Concep Lor Concep Concep Lor	59767] I Rece lled re	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -VOL-1] ten carb  focus s 1: Exe -1-VOL-1 iver hyb ceiver c y 1] producti	rid Power oncept. Vections 1 rid Power oncept. Vections 5 ell cogene facility, onate fuel cutive sur power sur oncept. Vection power sur power sur oncept. Vection power sur p	p0749 Systems Folume 2 through p0645 Systems Folume 2 and 6 and 6 p0645 eration wolume p0749 cell 1 p0750 cal powe mary p0648 systems p0648 systems	M80-31870 , book 480-31896 , book M80-31897 in a 1 1 M80-31922 ower M80-31938 r M80-31943 :	•
Soll Soll Soll Soll Soll Soll Soll Soll	INSA-CR-1 Lar Centra sodium-coc Lar Concep Lar Centra sodium-coc s	59767] I Bece lled rec lled red for total d for total d study: ution of mol nology 440/1] f line volume lled rec lled re	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -VOL-1] ten carb  focus s 1: Exe1-VOL-1 iver hyb ceiver c y 1] producti particul	rid Power oncept. Vections 1 rid Power oncept. Vections 5 ell cogenefacility, onate fuel colar centroutive sur 1 rid power oncept. Vections 5	p0749 Systems Folume 2 through p0645 Systems Folume 6 p0645 Pation volume e p0749 cell p p0750 cal powe maary p0648 Systems p0648 Systems p0648 Systems p0710	#80-31870 , book #80-31896 , book #80-31897 in a 1 #80-31922 ower #80-31938 r #80-31943 : #80-31948	•
Sold Sold Sold Sold Sold Sold Sold Sold	INASA-CR-1 iar Centra iar Centra iodium-coc l: Concept lar Centra iodium-coc l: Concept locate C	59767] I Becelled reduction of the second of	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -VOL-1] ten carb  focus s 1: Exe1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t	rid Power oncept. Yections 1 rid Power oncept. Yections 5 ell cogene facility, onate fuel cutive sur power sate controlections on power sate controlections of the controlection of the controlections	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 ration p0645 ration volume p0749 cell 1 p0750 cal power maary p0648 systems yolume 2 p0648 systems p0749 p0648 program	#80-31870 , book #80-31896 , book #80-31897 in a 1 #80-31922 ower #80-31938 r #80-31943 : #80-31948	•
Soli Soli Soli Soli Soli Soli Soli Soli	INASA-CR-1 Lar Centra sodium-cod 1: Concep Car Concep Car Concep	59767] I Receiled received a description of the control of the con	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control ten carb focus s 1: Exe -1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t sign Des	rid Power oncept. Vections 1 rid Power oncept. Vections 5 ell cogene facility, onate fuel cutive sur power sate controlections on power sate controlections of the controlection	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 ration p0645 ration volume p0749 cell 1 p0750 cal power maary p0648 systems yolume 2 p0648 systems p0749 p0648 program	#80-31870 , book #80-31896 , book #80-31897 in a 1 #80-31922 ower #80-31938 r #80-31943 : #80-31948	•
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 Lar Centra sodium-coo I: Concep Lar Centra sodium-coo I: Concep Lar Centra sodium-coo I: Concep BOE/ET-20 sibility rater poll POB/ET-12 relopment relant tech DOE/ET-15 luation o Systems. ATR-60 (77 Lar centra sodium-coo IIII poll III po	59767] I Bece lled red tual d I Bece lled red tual d I Bece lled red tual d Second tual tual tual tual tual tual tual tual	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control ten carb focus s 1: Exe -1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t sign Des	rid Power oncept. Vections 1 rid Power oncept. Vections 5 ell cogene facility, onate fuel cutive sur power sate controlections on power sate controlections of the controlection	p0749 Systems Folume 2 through p0645 Systems Folume 6 p0645 ration wolume e p0749 cell g p0750 cal powe maary p0648 systems p0648 systems p0648 systems p0710 program (OPDD)	M80-31870 , book 480-31896 , book M80-31897 in a 1 M80-31922 ower M80-31938 r M80-31943 : M80-31943	• •
Sold Sold Sold Sold Sold Sold Sold Sold	INAS-CR-1 iar Centra iar Centra iodium-coc l: Concept lar Centra iodium-coc l: Concept look/ET-20 look/ET-20 look/ET-20 look/ET-20 look/ET-10 look/ET-11 look/ET-12 look/ET-15 luation o look/ET-20 luation o look/ET-20 luation o look/ET-20 luation o luation	59767] I Receiled reduction of the second of	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -VOL-1] ten carb  focus s 1: Exe1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t sign Des	rid Power oncept. Vections 1 rid Power oncept. Vections 5 ell cogene facility, onate fuel cutive sur power sate control contro	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 node 45 station volume p0749 cell 1 p0750 cal power maary p0648 systems p0648 systems p0710 program (OPDD)	M80-31870 , book 486-31896 , book 180-31897 in a 180-31922 ower 180-31938 r 180-31943 : 180-31948	•
Sold Sold Sold Sold Sold Sold Sold Sold	INASA-CR-1 Lar Centra sodium-cod 1: Concep DOB/ET-20 Lar Centra sodium-cod 2: Concep DOE/ET-20 sibility water poll DOB/ET-12 relopment DOB/ET-15 Luation of Systems- ATR-60 (77 Lar centra Sizecutive DOB/ET-20 vanced sym ritilizing BNI-27783 db-tempera tyerall Pl coal-defiv pF-1806-6 db-tempera	59767] I Receiled received a description of the control of the con	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -vOL-1] ten carb  focus s 1: Exe -1-vOL-1 iver hyb ceiver c y 1] producti particul arbine t sign Des uid urbine t	rid Power oncept. Yetcions 1 rid Power oncept. Yetcions 5 ections 5 ections 5 ections 5 ections 5 ections 5 rid power contive sur 1 rid power oncept. Yetcions 5 echnology cription echnology	p0749 Systems Folume 2 through p0645 Systems Folume 2 p0645 eration volume p0749 L cell I p0750 cal power maary p0648 systems Folume 2 p0648 systems p0648 systems p0648 coll p0710 p0712 program p0712 program	M80-31870 , book 480-31896 , book M80-31897 in a 1 1 180-31922 ower M80-31938 r M80-31943 : M80-31948 M80-32570	•
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 iar Centra iar Centra codium-coc l: Concep loos/ET-20 loos/ET-20 loos/ET-20 loos/ET-20 loos/ET-12 loos/ET-12 loos/ET-12 loos/ET-12 loos/ET-13 luation of loos/ET-15 luation of loos/ET-16 luation of loos/ET-16 luation of loos/ET-17 luation of loos/ET-18 luation of loos/ET-19 luation of loos/ET-19 luation of loos/ET-20 lo	59767] I Received and the second and	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s Fuel c control focus s 1: Exe- 1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t sign Des urbine t sign Des	rid Power oncept. Vections 1 rid Power oncept. Vections 5 ell cogenefacility, onate fuel cutive sur lid power oncept. Vections 5 elections 5 ell cogenefacility on the control power second	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 ration volume 2 p0749 cell 1 p0750 cal power maary p0648 systems yolume 2 p0648 systems p0749 p0648 coll p0750 p0760 p0760 p0710 p0712 program (OPDD)	M80-31870 , book 480-31896 , book N80-31897 in a 1 M80-31922 ower N80-31948 : N80-31948 N80-32570	• •
Sold Sold Sold Sold Sold Sold Sold Sold	INASA-CR-1 Lar Centra sodium-cod 1: Concep DOB/ET-20 Lar Centra sodium-cod 2: Concep DOE/ET-20 sibility water poll DOB/ET-12 relopment DOB/ET-15 Luation of Systems- SYSTEMS-60 (77 Lar centra SECULIA CONCEP LOBE ET-20 danced sym stilizing BNI-27783 gb-tempera dverall Pl coal-deriv pl-tempera dverall Pl coal gase coal gase coal gase coal gase coal gase coel EP-1806-E CPE-1806-E CPE-18	59767] I Receiled received a discovered a di	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control - Tool-1] ten carb  focus s 1: Exe -1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t sign Des c power	rid Power oncept. Yet once the yet oncept. Yet once the yet oncept. Yet once the yet once	p0749 Systems Folume 2 through p0645 Systems Folume 2 p0645 eration volume e p0749 L cell I p0750 cal power maary p0648 systems Folume 2 p0648 systems p0648 systems p0648 coll program (OPDD) p0712 program (OPDD)	M80-31870 , book 480-31896 , book M80-31897 in a 1 1 M80-31922 ower M80-31943 : M80-31943 : M80-32728 ow-Btu B80-32728	• • •
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 Lar Centra sodium-coc 1: Concept Lar Centra sodium-coc 2: Concept BOE/ET-20 sibility rater poll POB/ET-12 relopment rater poll lant tech DOE/ET-15 luation of systems. ATR-60 (77 Lar centra sodium-coc DOE/ET-20 ranced syn BHI-27783 ph-tempera Docal-deriv FE-1806-8 ph-tempera	59767] I Receiled received described received described received r	iver Hybre ceiver cesign, so 2-8K-1] iver Hybre cesign, so 1: Exectly cesign, so 1: Exectly ceiver carbon durbine to sign Description of the ceiver cesign Description of the ceiver c	rid Power oncept. Yes carried power oncept. I cogene facility, onate fuel cutive sun on power sate contrology cription plant al receive	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 rolume p0749 tolume 2 rolume p0749 tolume p0750 cal power mary p0648 systems p0648 systems p0710 p0750 colume p0770 p0710 p0712 program (OPDD) p0752 er hybri	M80-31870 , book 4 M80-31896 , book M80-31897 in a 1 M80-31922 ower M80-31948 H80-31948 H80-32728 ow-Btu H80-32728	•
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 iar Centra iar Centra iodium-coc i: Concep lore/ET-20 lore/ET-20 lore/ET-20 lore/ET-20 lore/ET-20 lore/ET-20 lore/ET-20 lore/ET-20 lore/ET-10 lore/ET-15 luation of lore/ET-20 lo	59767] I Receive and I de le d	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control -VOL-1] ten carb  focus s 1: Exec -1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t sign Des urbine t sign Des c power ar centr olume 1:	rid Power oncept. Yes carried power oncept. I cogene facility, onate fuel cutive sun on power sate contrology cription plant al receive	p0749 Systems Yolume 2 through p0645 ration p0645 ration p0749 cell p p0750 cal power maary p0648 systems yolume 2 p0710 p0750 cal power maary p0648 systems yolume 2 program (OPDD) p0712 program (OPDD) p0752 er hybrive summa	M80-31870 , book , book 180-31897 in a 1 180-31922 ower 180-31943 : 180-31948 180-32570 180-32728 ow-Btu 180-32729 d power 179	
Sold Sold Sold Sold Sold Sold Sold Sold	INASA-CR-1 Lar Centra sodium-cod 1: Concept Lar Centra sodium-cod 2: Concept Lar Centra sodium-cod 2: Concept Local Centra sodium-cod 2: Concept Local Centra sodium-cod Lar Centra Lar Cen	59767] I Receiled received a description of the control of the con	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control iver hyb focus s 1: Exe -1-VOL-1 iver hyb ceiver c y 1] urbine t sign Des uid urbine t sign Des c power ar centr olume 1: 1]	rid Power oncept. Yet once the yet oncept. Yet once the yet once	p0749 Systems Folume 2 through p0645 Systems Folume 2 p0645 eration volume e p0749 L cell I p0750 cal power maary p0648 systems Folume 2 p0760 p0760 p0712 program (OPDD) p0752 er hybri ve summe p0588	M80-31870  , book  480-31896  , book  180-31897  1 1  180-31922  ower  180-31943  :  180-31943  :  180-32726  ow-Btu  180-32726  d power  180-32867	
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 Lar Centra sodium-coo 1: Concept Lar Centra sodium-coo 2: Lar	59767] 1 Received a decirated	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control focus s 1: Exe- 1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t sign Des c power ar centr olume 1: 1] ar centr	rid Power oncept. Yet once the yet oncept. Yet once the yet once	p0749 Systems Folume 2 through p0645 Systems Folume 2 p0645 eration volume e p0749 L cell I p0750 cal power maary p0648 systems Folume 2 p0760 p0760 p0712 program (OPDD) p0752 er hybri ve summe p0588	M80-31870  , book  480-31896  , book  180-31897  1 1  180-31922  ower  180-31943  :  180-31943  :  180-32726  ow-Btu  180-32726  d power  180-32867	
Sold Sold Sold Sold Sold Sold Sold Sold	INASA-CR-1 Lar Centra sodium-cod 1: Concept Lar Centra sodium-cod 2: Concept Lar Centra sodium-cod 2: Concept Local Centra sodium-cod 2: Concept Local Centra sodium-cod Lar Centra Lar Cen	59767] 1 Receive and the second and	iver Hyb ceiver c esign, s 2-BK-1] iver Byb ceiver c esign, s 2-BK-2] Fuel c control -VOL-1] ten carb  focus s -1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t sign Des urbine t sign Des c power ar centr olume 1: lume 2	rid Power oncept. Yet once the yet oncept. Yet once the yet once	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 rolume 3 rolume 4 rolume 4 rolume 4 rolume 4 rolume 4 rolume 5 rol	M80-31870  , book  480-31896  , book  180-31897  1 1  180-31922  ower  180-31943  :  180-31943  :  180-32726  ow-Btu  180-32726  d power  180-32867	
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 Lar Centra sodium-coc l: Concept Lar Centra sodium-coc l: Concept Lar Centra sodium-coc l: Concept Lore Concept	59767] 1 Receiled red	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control iten carb focus s 1: Exe -1-VOL-1 iver hyb ceiver c y 1] urbine t sign Des uid urbine t sign Des c power ar centr olume 1: 1] ar centr 1] ar centr 1] ar centr	rid Power oncept. Yet once the yet oncept. Yet once the yet once	p0749 Systems Yolume 2 through p0645 Systems Yolume 2 p0749 tolume 2 p0749 cell I p0750 cal power mary p0648 systems p0648 systems p0710 program (OPDD) p0752 er hybri ye summe p0586 er hybri	M80-31870 , book 4 M80-31896 , book M80-31897 in a 1 M80-31922 ower M80-31943 : M80-31948 H80-32570  M80-32728 ow-Btu H80-32729 d power Ly M80-32867 d power M80-32868	
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 Lar Centra codium-coc lar Concept Lar Concept Lar Concept Lar Centra codium-coc lar Centra codium-coc lar Centra codium-coc lar Centra lar Centr	59767] 196767 11 Receive and the second and the sec	iver Hyb ceiver c esign, s 2-BK-2] iver Byb ceiver c esign, s 2-BK-2] fuel c control -VOL-1] ten carb focus s 1: Exec- 1-VOL-1 iver hyb ceiver c y 1] producti particul urbine t sign Des urbine t sign Des ar centr olume 1: 1] tems ana	ocesses rid Power oncept. 1 rid Power oncept. 1 ections 1 rid Power oncept. 1 ections 5 ell cogene facility, onate fuel cutive sun rid power oncept. 1 on/power sate contro echnology cription plant al receive al receive lysis	P0749 Systems Yolume 2 through P0645 Systems Yolume 2 rolume 3 rolume 4 rolume 3 rolume 4 rolume 4 rolume 4 rolume 4 rolume 4 rolume 5 rol	M80-31870 , book 480-31896 , book 180-31897 11 a 31897 11 80-31922 ower 180-31948 180-31948 180-32570 180-32728 0w-Btu 180-32729 d power 180-32867 d power 180-32868 180-32881	
Sold Sold Sold Sold Sold Sold Sold Sold	INSA-CR-1 Lar Centra sodium-coc l: Concept Lar Centra sodium-coc l: Concept Lar Centra sodium-coc l: Concept Lore Concept	59767] 1 Received a dispersion of the control of th	iver Hyb ceiver c esign, s 2-BK-1] iver Hyb ceiver c esign, s 2-BK-2] Fuel c control iver hyb ceiver c y 1] producti producti producti producti purbine t sign Des c power ar centr lume 1: 11 ar centr lume 2 2 1 tems ana ar centr	rid Power oncept. Yections 1 rid Power oncept. Yections 5 ections 6 ections 6 ections 7 ection 6 echnology 6 echnology 7 ection 6 echnology 7 ection 6 ections 6 ectio	p0749 Systems Folume 2 through p0645 Systems Folume 2 p0645 eration volume e p0749 cell p p0750 cal power p0648 systems yolume 1 p0750 p0750 p0761 p0760 p0761 p0770 p0772 program (OPDD) p0752 er hybri ve summar p0586 p0753 er hybri p0586	M80-31870 , book 480-31896 , book 180-31897 11 a 31897 11 80-31922 ower 180-31948 180-31948 180-32570 180-32728 0w-Btu 180-32729 d power 180-32867 d power 180-32868 180-32881	

```
District heating and cooling systems for communities through power plant retrofit
      distribution network, volume 4
                                                p0753 #80-32942
   [COO-4977/1-VOL-4] p0753 H80
Environmental implications of electric utility
supply plans, 1978-2000
     supply plans,
[PB80-192156]
                                                p0588 N80-32963
   Environmental control technology for carbon dioxide
   [DOE/EV-0079] p0588 #80-32972
Simulation of the energy-industry-environment
     system for limited economic regions, using the example of Baden-Wuerttemberg. Part 1: Data,
      model development adaptation
                                                p0589 #80-32974
      [IKB-K-54-20-PT-1]
   Organic material emissions from holding ponds at
      coal-fired power generation facilities [BPBI-BA-1377] p05
   [BPRI-RA-1377] p0589 M80-32987
Systems assessment of heavy ion beam fusion drivers
                                                p0754 N80-33247
      [ DOE/DP-40039 ]
   Air Pollution control device configurations
[PB80-193253] p0593
                                                p0593 N80-33972
   Assessment of B2S control technologies for
     geothermal power plants [PB80-193709]
                                                p0593 N80-33973
ELECTRIC POWER SUPPLIES
   Large-scale electrical energy storage
                                                p0761 A80-44241
   Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data
      analysis
                                                p0761 A80-46414
   Down to earth operations --- centralized ground-based power distribution systems for aircraft fuel savings
                                                p0570 A80-46681
   Description of photovoltaic village power systems in the United States and Africa
                                                 p0609 A80-46796
   Progress in space power technology
                                                p0722 A80-48173
   The 100-kWp photovoltaic power system at Natural
      Bridges National Monument
                                                p0615 A80-48227
   Residential photovoltaic systems
                                                p0615 A80-48228
   Intermediate load-center photovoltaic application
      experiments
                                                p0615 A80-48230
   470-kW photovoltaic power system for Saudi Arabia
      villages
                                                p0616 A80-48232
   High performance photovoltaic systems
                                                p0616 A80-48233
   Calcium/iron disulfide secondary cells
                                                p0764 A80-48239
   Low maintenance lead-acid batteries for energy
      storage
   p0765 A80-48326
Bickel hydrogen battery for load leveling
      application
                                                p0766 A80-48328
   Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells
                                                p0766 A80-48329
   Temperature limitations of alkaline battery
      electrodes
                                                p0766 A80-48330
   An analysis of aluminum-air battery propulsion
      systems for passenger vehicles
                                                p0771 A80-48471
   Lead-acid traction batteries for electric road
      vehicle propulsion Directions for research and
      development
                                                p0772 A80-48766
   Fuel cell systems for vehicular applications [SAE PAPER 800059] p0736 A
                                                p0736 A80-49720
   Analysis of the infrastructure for recharging electric vehicles
      [SAR PAPER 800112]
                                                p0773 A80-49729
   Concentrators and solar photovoltaics
                                                p0622 A80-50626
   Provision of electric power as a prerequisite and
      determining factor for safeguarding the
      industrial community and ensuring the economical
      development of the Third World
                                                 p0575 A80-50824
   Resistance rise in sodium-sulphur cells
                                                P0774 A80-51698
```

SUBJECT INDRI ELECTROCHEMISTRY

LECTRIC POWER TRANSMISSION	ELECTRICITY
Down to earth operations centralized	A new probabilistic simulation technique for
ground-based power distribution systems for	multiple energy storage devices for electric
aircraft fuel savings	utility generation system expansion planning
P0570 A80-46681	nodels
Bnvironmental data energy technology	p0774 N80-28855
characterizations: Coal [DOB/RV-0074] p0577 880-28882	Environmental data energy technology characterizations: Coal
Study of power management technology for orbital	[DOB/EV-0074] p0577 B80-28882
nulti-100KWe applications. Volume 3:	Direct electrochemical generation of electricity
Requirements	from coal
[HASA-CB-159834] p0759 H80-29845	[SAN-0115-105-1] p0752 B80-32865
Satellite power systems (SPS) concept definition	BLECTROCATALISTS
study. Volume 1: Executive summary	Fuel cell applied research: Electrocatalysis and
[NASA-CB-3317] p0759 N80-30901	materials
A study of a space communication system for the control and monitoring of the electric	[BNL-51053] p0742 H80-28920 Puel cell applied research: Blectrocatalysis and
distribution system. Volume 1: Summary	materials
[HASA-CR-163477] p0760 H80-31268	[BNL-51072] p0744 N80-29885
LECTRIC PROPULSION	Aqueous trifluoromethanesulfonic acid fuel cells
Recent progress in lithium/iron sulfide battery	[AD-A086579] p0745 N80-30905
development	Materials for fuel cells
p0762 180-48188	[PB80-182355] p0748 880-30955
An advanced technology iron-nickel battery for electric vehicle propulsion	Cell module and fuel conditioner [NASA-CR-159888] p0749 N80-31882
p0766 180-48327	Oxygen electrodes for energy conversion and storage
An analysis of aluminum-air battery propulsion	[DOE/ET-25502/1] p0753 N80-32878
systems for passenger vehicles	BLECTROCHEMICAL CELLS
p0771 A80-48471	Large-scale electrical energy storage
Blectric propulsion for SFS	p0761 A80-44241
p0643 N80-31466	A new rechargeable high voltage low temperature molten salt cell
NASA technology program overview p0782 N80-33467	p0764 A80-48237
Air Porce space power technology program	Calcium/iron disulfide secondary cells
p0782 N80-33468	p0764 A80-48239
LECTRIC POLSES	Status of electrochemical energy storage systems
Effect of positive pulse charge waveforms on cycle	for electric Vehicle, solar, and electric
life of nickel-zinc cells p0766 A80-48329	utility applications p0765 A80-48325
LECTRIC TERMINALS	The aluminum-air battery for electric vehicle
Photovoltaic module electrical termination design	propulsion
requirement study	p0768 A80-48373
[JPL-955367-80/1] p0644 H80-31877 LECTRICAL REGIMERRING	Development status of the General Electric solid
The dc superconducting power transmission line	polymer electrolyte water electrolysis technology p0662 180-48413
project at LASL: US DOE division of electric	Some chemistry in the Li/SOC12 cell
energy systems	p0774 A80-51688
[LA-8323-PR] p0759 N80-30656	Electrochemical photovoltaic cells, project 65021
MOD-2 wind turbine farm stability study	[DSE-4042-T8] p0742 880-28910
[NASA-CE-165156] p0755 N80-33862 LECTRICAL PROPERTIES	Electrochemical energy storage systems for solar thermal applications
The influence of grain size and dopant	[NASA-CR-163432] r0636 N80-29858
concentration on the electrical properties of	Energy savings by means of fuel cell electrodes in
polycrystalline silicon films	electro-chemical industries
p0600 A80-46696	[COO-4881-12] p0745 N80-30902
Schottky barriers on sputtered hydrogenated	Advanced photovoltaic concentrator cells
amorphous silicon - Photovoltaic properties and	[DSR-4042-T30] p0643 N80-30946
capacitance-voltage characteristics p0602 A80-46720	Advanced photovoltaic concentrator cells [DSB-4042-T40] p0645 N80-31904
Some electric and photoelectric properties of	Photoelectrochemical solar cells based on d-band
photodetectors based on epitaxial layers	electrochemistry at transition metal diselenides
Si/x/Ge/1-x/ with diffused p-n junction	[IS-4724] p0648 N80-31952
p0610 A80-47153	Direct electrochemical generation of electricity
Pilot line report: Development of a high	from coal [SAN-0115-105-1] p0752 N80-32865
efficiency thin silicon solar cell [NASA-CB-163522] p0644 N80-31876	Electrochemical photovoltaic cells cdSe thin film
Photovoltaic module electrical termination design	electrodes
requirement study	[DSE-4042-T16] p0654 N80-32925
[JPI-955367-80/1] p0644 #80-31877	Aluminum air battery for electric vehicle propulsion
LECTRICAL RESISTANCE	[UCRL-84443] p0779 N80-32941
Safety studies on Li/SO2 cells. V - Effect of	Lithium batteries. Citations from the NTIS data base
design variables on the abuse resistance of hermetic D cells	[PB80-812399] p0779 N80-32967
p0737 A80-50509	BLECTROCREMICAL OXIDATION
Distributed series resistance in photovoltaic	Some chemistry in the Li/SOC12 cell
devices - Intensity and loading effects	p0774 A80-51688
p0624 A80-51118	BLECTROCARAISTRY  Lead-acid bettery expender I - Plactrochemical
Simulation of a solar energy system by means of an electrical resistance network	Lead-acid battery expander. I - Electrochemical evaluation techniques
p0625 A80-51686	p0761 A80-47137
Resistance rise in sodium-sulphur cells	Photoelectrochemical investigation on trigonal
p0774 A80-51698	selenium film electrodes
LECTRICAL RESISTIVITY	p0610 A80-47139
Optimized grid patterns for Cu2S-CdS solar cells p0621 A80-49322	The kinetics of the 02/C02 reaction in molten carbonate - Reaction orders for 02 and C02 on NiO
D.C. electrical conductivity of Green River oil	in fuel cells
shales	p0726 A80-48284
p0685 A80-50278	′

Recent progress on the sulfur cycle hybrid	HYFIRE - Pusion-high temperature electrolysis system
hydrogen production process	p0731 A80-48448
p0663 A80-48460 MHD electrode development	A comparison of capital cost estimates and process
[FE-15529-5] p0748 #80-31222	efficiencies for hydrogen production by thermochemical cycles and water electrolysis
Photoelectrochemical solar cells based on d-band	p0663 A80-48458
electrochemistry at transition metal diselenides	Off-peak power for hydrogen production
[IS-4724] p0648 N80-31952	p0663 180-48461
Electrochemical Orbital Energy Storage (ECOES) technology program regenerative fuel cell	A hybrid water-splitting cycle using copper sulfate and mixed copper oxides
system	p0664 180-48503
р0780 н00-33473	A theoretical study of the modelling and control
D.C. electrical conductivity of Green Biver oil	of a solar water electrolysis plant p0621 180-48919
shales	The thermodynamics of aqueous water electrolysis
p0685 A80-50278	p0664 A80-50511
ELECTRODEPOSITION  Electrowinning of silicon from K2SiP6-nolten	Models for the photoelectrolytic decomposition of
fluoride systems	water at semiconducting oxide anodes p0664 A80-50512
p0622 A80-50510	Application of the fusion reactor to
Low cost solar cells based on amorphous silicon	thermochemical-electrochemical hybrid cycles and
electrodeposited from organic solvents [SAB-0113-040-T7] p0637 880-29873	electrolysis for hydrogen production from water p0664 A80-51460
Oxidation of electrodeposited black chrome	Hydrogen production. Citations from the HTIS data
selective solar absorber films	base
[SANC-80-1045C] p0656 N80-32953	[PB80-810476] p0665 N80-29519
BLECTRODES Lead-acid battery expander. I - Electrochemical	Electrolysis-based hydrogen storage technology [BBL-26923] p0647 N80-31928
evaluation techniques	Low cost solar cells based on amorphous silicon
p0761 A80-47137	electrodeposited from organic solvents
Photoelectrochemical investigation on trigonal selenium film electrodes	[SAN-0113-040-T6] p0648 N80-31953
p0610 180-47139	Hydrogen production from remote power sites [BH1-27457] p0666 H80-32553
New approach to electrode current collection for	Pusion reactors for hydrogen production via
Lial/iron sulfide cells	electrolysis
p0763 A80-48191 Aerospace nickel-cadmium/nickel-hydrogen electrode	[BNL-27782] p0667 #80-32559 Oxygen electrodes for energy conversion and storage
process facility	[DOB/RT-25502/1] p0753 880-32878
p0769 A80-48396	BLECTROLITES
The influence of contact pressure on the	Photoelectrochemical compatibility of n-WSe2 and
performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells	n-MoSe2 with various redox systems photodecomposition of semiconductor solar cell
p0739 A80-51459	surface
Behavior of secondary lithium and aluminum-lithium	p0610 A80-47141
electrodes in propylene carbonate p0774 A80-51690	Investigation of the characteristics of electrochemical coatings for solar-radiation
Visible light response of polycrystalline TiO2	collectors
electrodes for solar energy conversion	p0611 A80-47164
p0664 A80-51691 Development of advanced batteries at Argonne	Development of a 7 kW #2/02-fuel cell assembly with circulating electrolyte in a compact
National Laboratory	nodular design
[ANL-80-32] p0776 H80-30927	p0739 A80-51692
MHD electrode development [FR-15529-5] p0748 N80-31222	Electrochemical energy storage systems for solar thermal applications
Blectrochemical photovoltaic cells cdSe thin film	[NASA-CR-163432] p0636 N80-29858
electrodes	Development of sodium sulfur batteries
[DSE-4042-T16] p0654 B80-32925	[BHFT-FB-T-79-60] p0776 N80-29905
Lithium batteries. Citations from the Engineering Index data base	Energy savings by means of fuel cell electrodes in electro-chemical industries
[PB80-812407] p0779 N80-32968	[COO-4861-12] p0745 B80-30902
Optimal thermionic energy conversion with	Aqueous trifluoromethanesulfonic acid fuel cells
established electrodes for high-temperature topping and process heating coal combustion	[AD-A086579] p0745 N80-30905 Development of the zinc-chloride battery for
product environments	utility applications
[NASA-TH-81555] p0754 H80-33221	[EPRI-RM-1417] p0778 N80-32917
Toroidal cell and battery energy storage for orbital space applications or power cells for	BLECTROLYTIC CBLLS Batteries for solar electricity
electric vehicles	p0605 A80-46747
[NASA-CASE-LEW-12918-1] p0780 N80-33857	Semiconductor-electrolyte solar cells for the
RIECTROHYDRODY WANICS Retinated performance of an electrohydrodynamic	photoelectrochemical reduction of carbon dioxide
Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector	to organic fuel p0605 180-46755
[AIAA PAPEE 80-1341] p0717 A80-44126	Cycle life studies of LiAl/PeS cells using BM felt
The dispersion relation of electrothernal waves in	separators
a nonequilibrium magnetohydrodynamic plasma closed cycle magnetohydrodynamic generators	p0763 A80-48189  New approach to electrode current collection for
[TH-78-E-92] p0744 H80-30198	Lial/iron sulfide cells
BLECTROLYSIS	p0763 A80-48191
Heavy water as a valuable by-product of	Development of a tubular lithium-iron sulfide cell
electrolytic hydrogen p0661 180-47665	p0763 A80-48192 Scaling up of bipolar lithium/iron disulfide cells
The MARK-13 process for hydrogen production	p0763 A80-48193
p0662 180-48412	Development of a high temperature solid
Development status of the General Blectric solid polymer electrolyte water electrolysis technology	electrolyte fuel cell p0726 A80-48281
p0662 A80-48413	Analysis of the application of thermogalvanic
High-temperature water electrolysis for hydrogen	cells to the conversion of low grade heat to
production	electricity

p0662 A80-48414

p0729 A80-48390

SUBJECT INDEX REFER CONSERVATION

Safety studies on Li/SO2 cells. IV -BLECTROSTATIC WAVES Investigations of alternate organic electrolytes Absolute dissipative drift-wave instabilities in for improved; safety tokamaks p0737 A80-50507 Evaluation of high temperature LiAl/TiS2 cells p0773 A80-50508 Safety studies on Li/S02 cells p0719 A80-00661 BLECTROBINGING Electrovinning of silicon from K2SiP6-molten Safety studies on Li/SO2 cells. V - Effect of design variables on the abuse resistance of hermetic D cells fluoride systems p0622 & 80-50510
Energy savings by means of fuel cell electrodes in
electro-chemical industries
[COO-4881-12] p0737 A80-50509 Toroidal cell and battery --- energy storage for orbital space applications or power cells for BHITTABCE electric vehicles An emissometer with high accuracy for determination of the total hemispherical emittance of surfaces --- of solar energy [NASA-CASE-LEW-12918-1] RESCTRONAGESTIC MEASUREMENT p0780 N80-33857 Electromagnetic methods in applied geophysics absorbers p0621 A80-48947 Effect of a heated atmosphere on the emittance of p0669 A80-46170 BLECTROMAGNETIC RADIATION Conceptual design of RST: An rf-driven, steady-state Tokamak black chrome solar collector pipe surfaces [UCRL-83506] p0631 B p0631 N80-28677 [EPRI-AP-1351]
RLECTRONECHANICAL DEVICES p0751 N80-32233 BMULSIONS Investigation of fuels containing coal-oil-water enulsions fire tube test apparatus Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation [ DOE/ET-10634/T1] p0691 N80-28552 Preparation and stability of emulsions of methanol in automotive diesel cil P0577 #80-28856
Environmental assessment. Energy efficiency
standards for consumer products
[D0E/CS-01681 [PB80-169162] p0697 N80-2952
Preparation and stability of emulsions of methanol in automobile diesel oil p0697 N80-29526 [CSIR-CBBG-294] ELECTRON BEAMS p0713 N80-33579 Theoretical multiple beam overlap from channel transport of intense particle beams RMCAPSULATING Study of randwich type glass encapsulation --- of solar cells p0735 A80-49067 p0602 A80-46714 Grad B focusing and deposition of relativistic Physical/chemical modeling for photovoltaic module electron beams life prediction p0717 A80-43972 p0608 A80-46790 BLECTROM DEWSITY PROFILES

Density profiles in tokamaks from electron cyclotron radiation spectra REFREY ARSORPTION PILES Advanced thin silicon solar cell with controlled optical absorptance --- for space power systems p0738 A80-51018 and arrays RESCUROR INPADIATION An S.B.M. study of thin films made by spray pyrolysis --- CdS deposition on solar Comparison of silicon solar cell characteristics at operating temperature after electron photovoltaic panels irradiation p0603 A80-46729 p0659 N80-33890 RIECTRON PLASEA Also as a potential photovoltaic material P0608 A80-46786 Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in Solar selective black cobalt - Preparation, large tokamaks structure, and thermal stability D0738 A80-51038 p0609 A80-46933 Current status of growth processes for solar grade Density profiles in tokamaks from electron cyclotron radiation spectra silicon p0620 A80-48789 Photovoltaic conversion - Recent progress in solid p0738 A80-51018 BLECTRON RECOMBINATION state solar cells p0620 A80-48790 Interface recombination and junction field studies in the Cu2S-CdS solar cell Development of a cadmium selenide thin film solar p0603 A80-46724 cell. **ELECTRON TRAJECTORIES** [BMFT-FB-T-79-72] p0640 N80-29907 Thin films of InP for photovoltaic energy conversion
[COO-3004-2] p0642 N80-30912
Analytical prediction of the performance of an air Grad B focusing and deposition of relativistic electron beams p0717 A80-43972 photovoltaic/thermal flat plate collector [DOE/ET-20279/93] p0653 RERCTRON TUBES p0653 N80-32914 Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in BREEGY CONSERVATION large tokamaks The tax on waste heat - An instrument of economic p0738 A80-51038 policy for preserving resources RLECTRON-ION RECORDINATION Experimental evidence of charge-exchange recombination of highly ionized iron and titanium in Princeton large torus Energy to the 21st century: Proceedings of the Pifteenth Intersociety Energy Conversion Engineering Conference, Seattle, Wash., August 18-22, 1980. Volumes 1, 2 and 3 p0735 A80-48765 RERCTRONIC CONTROL p0722 A80-48165 Energy conservation and environmental benefits of Operational characteristics of a 60 km photovoltaic system integrated with a utility grid p0609 A80-46797 thermal energy storage systems in the pulp and paper industry p0763 A80-48194 Industrial energy conservation with the natural gas-fueled molten carbonate fuel cell REPORTE BODGERS Bickel-cadmium batteries for the Hodular Power Subsystem --- of Hultimission Hodular Spacecraft
p0769 A80-48398 p0571 A80-48280 The OASIS computer program for optimization and simulation of integrated systems --- for energy RESCIPOPLATING Solar selective black cobalt - Preparation, structure, and thermal stability production and utilization at community level Energy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514 p0571 A80-48333 p0609 A80-46933 REPORTATIO PRECIPITATORS International Conference on Air pollution, volume 4 p0592 880-33954

EBERGY CONSUMPTION SUBJECT INDEX

Life cycle cost analysis in residential buildings and consumer appliances	Simulation model for assessing building energy-conservation policies
p0572 A80-48515  Energy conservation in terminal airspace through fuel consumption modeling	[BNL-27802] Appraisal of the B factor and the role of building thermal mass in energy conservation
[SAE PAPER 800745] p0573 A80-49695	[ORML/COM-46] p0588 N80-32958
Energy savings in a rotary kiln in the production	Basic Research in Engineering: Process and
of cement through the addition of domestic waste and sewage sludge	Systems Dynamics and Control. High Priority Research Needs Relevant to Energy
P0574 A80-49958	[FE-2468-65] , p0590 N80-33167
Ocean thermal energy conversion contribution to	Relevance of the second law of thermodynamics to
the energy needs of the United States p0737 A80-50909	energy conservation [DOE/CS-40178/01-VOL-1] p0590 B80-33288
Energy Conservation with flywheels	Energy policy: Supply and demand alternatives
p0773 A80-50911 Energy conservation and solar houses	[GPO-56-541] p0591 N80-33870 Incentives for energy conservation .
p0623 A80-50941	[GPO-55-634] p0591 H80-33871
The development of thermal energy storage systems exploiting solid-solid phase transitions	Working group on fuel consumption targets [NP-24333] p0591 N80-33910
p0774 A80-50970	Conservation and solar energy programs of the
TIDP - Basic research for answering Plorida's residential energy conservation questions	Department of Energy: A critique
p0576 A80-51954	[FB80-197759] p0591 N80-33922 Energy: Careful conservation or regulated waste
Solar energy for buildings handbook	control of automobile exhaust emissions
[ORO-5362-T1] p0631 N80-28880	p0592 N80-33951
Heat-pump-centered integrated community energy systems: System development summary	ENERGY CONSUMPTION OTEC research in Japan
[AHL/CHSV-7] p0578 N80-28885	p0718 A80-44600
Simplified energy design economics: Principles of	An update of OTEC baseline design costs
economics applied to energy conservation and solar energy investments in buildings	p0718 A80-44604 Mid-range energy forecasting system - Structure,
[PB80-179245] p0634 H80-29534	forecasts, and critique
The coating industry: Inergy savings with	p0570 A80-46335
volatile organic compound emission control [TID-28706] p0579 N80-29833	Methane recovery from urban refuse
[TID-28706] p0579 N80-29833 Alternative metering practices. Implications for	p0670 A80-47587 The direction and scope of the U.S. Department of
conservation in multifamily residences	Energy's surface coal gasification program
[HCP/M1693-03] p0579 N80-29838	p0672 180-48242
Minimizing consumption of exhaustible energy resources through community planning and design.	Solar coal gasification p0616 A80-48243
Development of procedures for application during	A simulation model for wind electric systems
public facilities procurement process. Phase 2: Extension	p0734 A80-48522
[BLO-2332-3] p0580 N80-29840	Solar energy utilization in a collective habitat - The Fribourg Solar House in Brisgau
Human comfort and auxiliary control considerations	p0620 A80-48795
in passive solar structures [LBL-10034] p0640 180-29903	Social acceptance of energy systems - Some
Industrial application and assessment of waste	observations on the situation in the Third World p0572 A80-49025
energy recovery technologies	Impact of electric cars on national energy .
p0745 N80-30886 Pacific Missile Test Center energy projects.	Consumption [SAE PAPER 600111] p0573 A80-49728
Summary of projects, contributions, and plans	Alternative energy futures. Part 1: The future
[AD-A086196] p0581 N80-30903	of liquefied natural gas imports
Energy analysis program, FY 1979 [LBL-10320] p0582 N80-30942	[PB80-173552] p0693 N80-28574 Refinery energy profile
Evaluation of the Ram-Jet device, a PCV air bleed	[ORO-5262-5-SUPPL] p0577 N80-28857
[PB80-170657] p0582 B80-30964 Electric and hybrid vehicle system research and	International energy indicators
development project: Hybrid vehicle potential	[DOS/IA-0001T/3(80)] p0781 H80-28919 Alternative metering practices. Implications for
assessment. Volume 1: Summary	conservation in multifamily residences
[CONS-4209-T1-VOL-1] p0583 N80-31272 Electric and hybrid vehicle system research and	[#CP/M1693-03] p0579 N80-29838 Characteristics of the housing stock and
development project, hybrid vehicle potential	households: Preliminary findings from the
assessment. Volume 6: Cost analysis	National Interim Energy Consumption Survey
[CONS-4209-T1-VOL-6] p0583 #80-31274 Electric and hybrid vehicle system research and	p0579 N80-29839
development project, hybrid vehicle potential	Intergenerational equity and conservation [NASA-CR-163434], p0580 N80-29861
- assessment. Volume 8: Scenario generation	Passive solar heating and natural cooling of an
impact of hybrid vehicles on petroleum consumption	earth-integrated design
[CONS-4209-T1-VOL-8] p0583 N80-31275 Energy budget procedures and performance criteria	[COMP-800449-1] p0638 M80-29884 Buman comfort and auxiliary control considerations
for energy conserving building illumination	in passive solar structures
systems	[LBL-10034] p0640 B80-29903
[PB80-184229] p0583 M80-31673 Assessment of industrial energy conservation by	Peasibility study for industrial cogeneration fuel cell application
unit processes	[SAN-1889-T1] p0746 N80-30934
[ORAU/IEA-80-4(M)] p0584 N80-31939	Comparative assessment of five long-run energy
Pilot study to select candidates for energy.  Conservation research for the chemical industry	projections [DOB/RIA/CE-0016/02] p0582 M80-30936
[DOE/TIC-11114] p0584 880-31940	Documentation of volume 3 of the 1978 Energy
Reduction of fuel consumption by thermodynamic	Information Administration annual report to
optimization of the Otto motor: Comparative investigation of Otto diesel engines	Congress
[EUR-6711-DE] , p0585 880-32733	[DOE/EIA/CR-0456] p0782 N80-32869 Photovoltaic applications definition and
Thermal energy storage for building heating and	photovoltaic system definition study in the
cooling applications	agricultural sector. Volume 2: Technical results
[OBNL/TH-7319] p07.77 #80-32879 Annual Cycle Energy System (ACES)	[SAND-79-7018/2-VOL-2] p0586 M80-32870
[ORNL/CON-42] p0587 N80-32880	

SUBJECT INDEX RURRGY CONVERSION

Simulation model for assessing building
energy-conservation policies
[BNL-27802] p0587 N80-32901
International energy indicators
[DOE/IA-0010] p0588 N80-32918 Appraisal of the M factor and the role of building
thermal mass in energy conservation
[OBNL/CON-46] P0588 N80-32958
Development of an energy consumption and cost data
base for fuel cell total energy systems and
conventional building energy systems
[ORNL/CON-38] p0754 N80-32960
Deep space network energy program
p0590 N80-33446
BRGY CONVERSION
Helium-topping/organic bottoming - Advanced power
generation system Exergetic/energetic analysis
p0673 A80-48247 The 1980 technology status of the Dynamic Isotope
Power System
p0725 A80-48255
Analysis of the application of thermogalvanic
cells to the conversion of low grade heat to
electricity
p0729 A80-48390
Thermoelectricity - Fhase diagrams and
imperfection structures. II
p0731 A80-48434
Energy conversion considerations of the STARPIRE
commercial fusion power plant
p0733 A80-48490
Environmental impact of conversion of refuse to
energy
p0574 180-49954  Faste handling Riinmond - Fnergy production of a
Waste handling Rijnmond - Energy production of a large-scale waste incineration plant
p0681 A80-49963
Refuse/sludge/hazardous waste co-disposal with
energy recovery
p0684 A80-50020
Second law analysis of energy devices and
processes: Proceedings of the Workshop, George Washington University, Washington, D.C., August
14-16, 1979
p0576 A80-51202
The use of refuse heat assisted by heat transformers
p0686 A80-51499
Development of a 7 km H2/02-fuel cell assembly
with circulating electrolyte in a compact
modular design p0739 A80-51692
Conversion system overview assessment. Volume 3:
Solar thermal/coal or biomass derived fuels
[SEBI/TR-35-078-VOL-3] p0630 H80-28569
The potential of energy farming for transport
fuels in New Zealand
[PB80~154248] p0693·N80-28572
The potential of energy farming for transport
fuels in New Zealand, appendices
[PB80-154255] p0693 N80-28573
Cogeneration Technology Alternatives Study (CTAS).
Volume 2: Analytical approach
[NASA-CE-159766] p0741 N80-28859
Environmental data energy technology characterizations: Coal
[DOE/EV-0074] P0577 N80-28882
Sun Valley photovoltaic power project, phase 1
[ALO-4281-1] p0633 180-28909
Electrochemical photovoltaic cells, project 65021
[DSE-4042-T8] p0742 N80-28910
Design of land-based, foam OTEC plants for
bottoming cycles
[CONF-790631-17] p0742 N80-28913
Altos-model 8B wind turbine generator.
Performance report
[RPP-3033/3533/79-4] p0742 N80-28926
Solar atrium: A hybrid solar heating and cooling
system
[DOE/CS-34135/6] p0633 N80-28928
Momentum theory analysis of unconventional wind
extraction schemes, part 10
[ASRL-TR-194-2-PI-10] p0742 H80-28932
Safety of wind energy conversion systems (WECS):  Preliminary study risk to personnel and to
. Preliminary study risk to personnel and to the surrounding area due to mechanical failure
[FFA-HU-2126] p0742 N80-28933

RN

The long-term effects of trace elements emitted by energy conversion of lignite coal. Volume 2: Technical appendices [PB80-168875] [PR80-168875] PD5-79 NOU-2050V
Solar heating and hot water system installed at
office huilding, One Solar Place, Dallas, Texas
[NASA-CR-161483] P0634 N80-29846
Solar heating and domestic hot water system
installed at North Dallas High School p0634 N80-29847 [NASA-CR-161482] Solar heating and cooling system installed at Leavenworth, Kansas [NASA-CR-161484] [NASA-CR-161484] p0635 N80-29848 Solar space heating for the Visitors Center, Stephens College, Columbia, Missouri
[NASA-CR-161485] p0635 N80-29849
Screening method for wind energy conversion systems p0635 N80-29849 [SEBI/TE-731-649] p0744 N80-29891 Hydrogen storage: Hydrogen as a hydride. Citations from the NTIS data base [PBB0-811094] p0665 M80-30561 Industrial application and assessment of waste energy recovery technologies p0745 N80-30886

Cogeneration Technology Alternatives Study (CTAS).
Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section A
[NASA-CR-159770-PT-1-A] p0745 N80-30888

Cogeneration Technology Alternatives Study (CTAS).
Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section B
[NASA-CR-159770-PT-1-B] p0745 N80-30889

Cogeneration Technology Alternatives Study (CTAS).
Volume 6: Computer data. Part 2:
Residual-fired nocogeneration process boiler
[NASA-CR-159770-PT-2] p0745 N80-30890

Rocky Flats Small Wind Systems Test Center activities. Volume 1: Atmospheric test data collected from Small Wind Energy Conversion Systems p0745 N80-30886 Systems Systems [RPP-3004-VOL-1] p0746 N80-30 Rocky Flats Small Wind Systems Test Center activities. Volume 2: Controlled Velocity, vibration and dynamometer testing of Small Wind p0746 N80-30907 Energy Conversion Systems [RFP-3004-VOL-2] [RFP-3004-VOL-2] p0746 N80-30908 Siting handbook for small wind energy conversion systems [PNL-2521-REV-1] p0747 N80-30941 Solar passive systems for buildings [NP-24377] p0643 N80-30947 Thermionic energy conversion. Citations from the NTIS data base [ PB80-810906] Cogeneration Technology Alternatives Study (CTAS).

Volume 3: Energy conversion system
characteristics [NASA-CR-159761] p0748 N80-31869 Cogeneration Technology Alternatives Study (CTAS).
Volume 3: Industrial processes
[NASA-CR-159767] p0749 N80-318 p0749 .N80-31870 Basic research needs and priorities in solar energy. Volume 2: Technology crosscuts for DOB [SERI/TR-351-358-VOL-2] p0645 N80-31899 Field experience with solar concentrating collector control systems [SAND-79-2044C] p0647 N80-31924 AC/DC power converter for batteries and fuel cells [EPRI-EM-1286] p0750 N80-31937 Hydrogen production from remote power sites [BNÍ-27457] p0666 N80-32553 Plash pyrolysis and gasification of coal through laser heating [ LA-UR-80-1094 ] p0711 N80-32573 Coal liquefaction [DOE/FE-0003/79-2] p0711 N80-32574 Biomass energy production. Citations from the International Aerospace Abstracts data base [ PB80-810807] p0711 N80-32578 Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-3287 p0586 N80-32870 Solar ponds and their applications [SERI/TP-733-617] [SERI/TP-733-617] p0655 N80-32947
Environmental assessment report: Wellman-Galusha low-Btu gasification systems [PB80-190796]

p0589 N80-32995

p0763 A80-48191

·	
Wind characteristics program element [PML-3211] p0754 M80-33073 MASA technology program overview	Pluorescent planar concentrators - Performance and experimental results solar collector absorbing diffuse and direct radiation via
p0782 N80-33467 Air Porce space power technology program	fluorescent molecules
p0782 N80-33468 Optimum systems design with random input and	Numerical modelling of a solar cell in three dimensions
output applied to solar water heating p0657 #80-33854 Cogeneration Technology Alternatives Study (CTAS).	p0605 A80-46749 Theoretical performance of multi-layer grid patterns for solar cells
Volume 4: Energy conversion systems [NASA-CR-159768] p0755 N80-33859 Cogeneration Technology Alternatives Study (CTAS).	p0605 A80-46752 Improvement of phosphorus diffused silicon solar cells by laser treatment
Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section A	p0606 A80-46763 Influence of the double exponential on the
[NASA-CR-159770-PT-1] p0591 N80-33860 Energy programs at the Johns Hopkins University Applied Physics Laboratory	efficiency and the yield of screen printed solar cells energy conversion effectiveness measurement
[PB80-195316] p0783 N80-33919 Energy conservation-air pollution abatement project p0592 N80-33939	p0606 A80-46764  High efficiency silicon solar cell for concentrator systems
BERGY CONVERSION EPPICIENCY	p0606 180-46767
Closed cycle MHD power plant and retrofit optimization application p0717 A80-44231	High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination
Ocean thermal energy conversion - A general	p0606 A80-46768
introduction p0718 A80-44599 Westinghouse OTEC power systems	Advances in theory, fabrication and applications of bifacial solar cells p0606 A80-46769
p0718 A80-44601 Wind energy planning - Development and application of a site selection method for wind energy	Efficient GaAs shallow-homojuncticn solar cells on single-crystal GaAs and Ge substrates p0608 A80-46783
conversion systems /WECS/	Alsh as a potential photovoltaic material p0608 A80-46786
A multiple p-n junction structure obtained from as-grown Czochralski silicon crystals by heat treatment - Application to solar cells p0595 A80-45121	Determination of the spectral distribution of global radiation with a rapid spectral radiometer and its correlation with solar cell
Power extraction from deep ocean waves employing a	efficiency po608 A80-46789
novel wave energy device [ASBE PAPER 80-PET-29] The sun-mill - A version of dunking-bird as an	Engineering studies on the optimization of the collection subsystem of A I MW photovoltaic facility
energy convertor of sun's radiation	p0609 A80-46794
p0596 A80-45459 Selenium heterostructure solar cells p0598 A80-46259	Limiting efficiencies of ideal single and multiple energy gap terrestrial solar cells p0609 A80-46951
The benefits of solar power satellites p0598 A80-46387	High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitamy
High-efficiency InP homojunction solar cells p0598 A80-46496	p0610 A80-46952 Efficiency of quantum-utilizing solar energy
Computer simulation of solar pond thermal behavior p0599 A80-46567	converters in the presence of recombination losses p0610 A80-46953
Oxide semiconductors in photoelectrochemical conversion of solar energy p0599 A80-46568	Theoretical investigations into collection coefficient for Cu/2-x/S-CdS cells with allowance for surface states at interface
Comprehensive explanation of efficiency limits in silicon solar cells	p0610 A80-47151 Estimating capacity of solar thermoelectric
p0600 A80-46697 Low-cost, high-efficiency silicon by heat	generator /STEG/ panels p0610 A80-47155
exchanger method and fixed abrasive slicing technique for solar cells p0600 A80-46700	Experimental investigation of thermal characteristics of solar thermoelement block p0611 A80-47157
Experimental optimization of the efficiency of n/+/-p-p/+/ and p/+/-n-n/+/ silicon solar cells	Investigation of temperature regime of single-story house with solar heating system
p0601 A80-46706 Optimization studies of materials in hydrogenated amorphous silicon solar cells	p0611 A80-47162 The design, application benefits, and economics of energy-efficient motors - A technological update
p0602 A80-46717 Evaluation of multijunction structures using amorphous Si-Ge alloys for solar cells	p0571 A80-47592 Solar-powered Bankine engine assists air conditioning systems with electrical generating
p0602 A80-46719 Thin film /Cd2n/S for solar cells	capability p0611 A80-47596
p0603 A80-46727 Concentration and temperature performances of GaAs-GaAlAs solar cells	A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038
p0603 A80-46734 Photovoltaic power generators in space	Surface passivation of inversion layer m.i.s. solar cells
p0604 A80-46735 A low cost solar simulator for testing	p0612 180-48150 Progress in space power technology
<pre>photovoltaic terrestrial solar power cells and modules</pre>	p0722 A80-48173 Photocell heat engine solar power systems
p0604 A80-46738 Photovoltaic generators using optical concentration	p0612 A80-48179 Recent progress in lithium/iron sulfide battery
p0604 A80-46739	development
Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency	p0762 A80-48188  Hew approach to electrode current collection for Lial/iron sulfide cells

P0604 A80-46740

SUBJECT TERRY Economic performance model of AFBC systems -Atmospheric Pluidized Bed Combustion P0571 A80-48199 Economic analysis of coal burning fluidized bed steam and hy-product power generation systems for industrial facilities p0672 A80-48200 GaAs solar cells for space applications p0613 A80-48203 The planar multijunction cell - A new solar cell for earth and space p0613 A80-48205 High-efficiency concentration/multi-solar-cell system for orbital power generation p0614 A80-48207 Concentrating photovoltaics - A viable candidate for the next generation of Air Force satellite power systems p0614 A80-48209 Condenser designs for binary power cycles --- in geothermal energy conversion p0723 A60-48221 Liquid-metal MHD for solar and coal - System and component status p0724 A80-48226 The HTGR-GT closed-cycle gas turbine - A plant concept with inherent cogeneration /power plus heat production/ capability p0724 A80-48248 Benefits arising from the use of pneumatic energy transmittal in wind-power systems p0757 A80-48271 Industrial energy conservation with the natural gas-fueled molten carbonate fuel cell p0571 A80-48280 Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315 The economics of compressed air energy storage with thermal energy storage

p0767 A80-48339 Results from the Hoe Creek No. 3 underground coal gasification experiment

p0675 A80-48340 A successful eastern in situ coal gasification field trial

p0675 A80-48342 A water-influx model for UCG with spalling-enhanced drying --- Underground Coal

Gasification p0676 A80-48343 An investigation of simultaneous heat and mass

transfer in subbituminous coal --- hot gas drying for underground ccal conversion p0676 A80-48344 Sorption of moisture and methane on Fruitland coal --- in underground coal conversion

p0676 A80-48346 Further analysis of a novel wave energy device p0728 A80-48352

Potential economics of large space based solar power stations

DO617 A80-48354 Overview of high efficiency power cycles for fusion p0728 A80-48358 Advanced power technology for fusion reactors p0728 A80-48359

Direct energy conversion for fusion power P0729 A80-48361 Key questions in the application of

salt-stratified solar ponds

generation

p0617 A80-48364 Laboratory demonstration of self-creation, self-maintenance and self-correction of

saturated solar ponds p0618 A80-48366 Solar ponds for district heating and electricity

p0618 A80-48367 Plywheel-transmission characteristics required for break-even impact on automotive vehicle

performance Performance loss due to transient heat transfer in the cylinders of Stirling engines

p0730 A80-48410 High-temperature water electrolysis for hydrogen production p0662 A80-48414 Catalytic combustion of hydrogen in model appliances The JPL parabolic dish project --- solar collectors technology decided

p0618 A80-48417 Collector temperature effects on the performance of advanced thermionic converters and nuclear electric propulsion systems

p0730 A80-48421 Status of COMSAT/INTELSAT nickel-hydrogen battery technology

Validation of published Stirling engine design methods using engine characteristics from the

p0734 A80-48497 A state space analysis of a symmetrical compounded free piston Stirling engine

p0734 A80-48498 Investigation of a Philips MP 1002 CA Stirling engine

p0734 A80-48499 An analytical solution for a Stirling machine with an adiabatic cylinder

p0734 A80-48501 Regenerative engines with dense phase working fluids - The Malone cycle

p0734 A80-48502 A comparison of the flat plate and concentrating

solar collector p0619 A80-48507

Thin film solar cells

p0619 A80-48513

A simulation model for wind electric systems p0734 A80-48522

A stochastic model for predicting solar system performance --- for water heating

High temperature solar energy conversion systems p0621 A80-48924 Impact of electric cars on national energy

consumption p0573 A80-49728 [SAE PAPER 800111]

The efficiency of recovering energy and materials from solid waste

Application of the energy concept to a resource recovery system

p0574 A80-49934 Instability analysis in a nonequilibrium HHD generator --- Thesis

p0737 A80-50357 The thermodynamics of aqueous water electrolysis p0664 A80-50511

Concentrators and solar photovoltaics D0622 A80-50626

Maximum windmill efficiency p0737 A80-50721

Theoretical analysis of new wavelength-division solar cells

- p0622 A80-50745 Photoelectrochemistry with p-Si electrodes -Effects of inversion

p0737 180-50760 Performance monitoring of low energy house, Macclesfield

p0575 'A80-50944 The photoklystron --- for satellite solar energy conversion

p0623 A80-50956 Degradation of solar cell performance by areal

inhomogeneity p0624 A80~51112

Temperature effects in silicon solar cells p0624 A80~51115

Dimensionless groupings for photovoltaic performance analysis

p0624 A80-51463 Describing-function method for estimating the performance of a dynamic system having nonlinear-power take-off, with application to wave-power conversion

p0739 A80-51464 Ammonia/water absorption cycles with relatively high generator temperatures

p0625 A80-51682 Trombe wall vs direct gain - A comparative analysis of passive solar heating systems p0626 A80-52828 EMBEGT DISSIPATION SUBJECT INDEX

Experimental investigation of the Trombe Wall passive solar energy system	Refinery energy profile [ORO-5262-5-SUPPL] p0577 #80-28857
p0627 A80-52833 A comparison of performance factors for passive solar heating	Relevance of the second law of thermodynamics to energy conservation [DOR/CS-40178/01-VOL-1] p0590 M80-33288
p0627 A80-52837	REERGY DISTRIBUTION
p0628 A80-52863 Gallium arsenide solar cells for use in	Reduction of intensity variations on the absorbers of ideal flux concentrators
concentrated sunlight	P0598 A80-46452 RHERGY GAPS (SOLID STATE)
p0628 A80-52864 Hybrid thermal-photovoltaic systems p0628 A80-52865	Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic conversion efficiency
Wind commercialization and Alcoa Vertical Axis Wind Turbines	p0604 A80-46740 Accurate computer analysis of solar cells
p0687 A80-52868 Ocean wave power available to submerged energy devices of finite dimensions	including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure p0607 A80-46782
p0689 k80-53681 Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation	Limiting efficiencies of ideal single and multiple energy gap terrestrial solar cells p0609 A80-46951
reports [SAB-1731-T2] p0577 B80-28856	Amorphous silicon solar cells p0622 A80-50625
Comparison of coal-fired power systems in waste	REREGI POLICY
heat applications in Tacoma, Washington [TID-29379] p0693 N80-28858	The tax on waste heat - An instrument of economic policy for preserving resources
Roof overhang design for solar control [CONF-791022-15] p0632 H80-28900 Cost-effective ways to improve the fabrication and	p0569 180-44764 Setting fire to the whole forest Belgian energy policy
installation of solar heating and cooling systems for residences	p0569 180-44780 The effect of demand uncertainty on the relative
[COO-4520-1] p0632 H80-28902 Concentrating solar collector test results	economics of electrical generation technologies with differing lead times
[SAND-80-0801C] p0633 N80-22912 Biomass liquefaction efforts in the United States [LBL-10456] p0696 N80-29512	p0570 A80-46336 A revised economic analysis of photovoltaic power modules
Solar energy system performance evaluation report for IBM System 4 at Clinton, Mississippi	p0602 A80-46715 Photovoltaics commercialization readiness assessment
[NASA-CR-161509] p0641 M80-30893 pilot line report: Development of a high	p0607 180-46772 Energy choices for the 1980s
efficiency thin silicon solar cell [BASA-CR-163522] Peasibility study: Fuel cell cogeneration in a	p0570 A80-47099 The direction and scope of the U.S. Department of Energy's surface coal gasification program
water pollution control facility, volume 1 [DOE/ET-12431/T1-VOL-1] Evaluation of control strategies for solar	p0672 A80-48242 The SPS concept - An overview of status and outlook Satellite Power System
collector loops [LBL-10716] p0647 #80-31932 Analytical evaluation of a solar	p0617 A80-48353 Potential economics of large space based solar power stations
thermophotovoltaic converter [SAND-78-1962] p0649 M80-31954	p0617 180-48354 Social acceptance of energy systems - Some
Improving the efficiency of silicon solar cells containing chromium	observations on the situation in the Third World p0572 A80-49025
[MASA-CASE-MPO-15179-1] p0650 M80-32850 glectrochemical photovoltaic cells cdSe thin film	Investing in coal international energy policy p0572 180-49391
electrodes [DSE-4042-116] p0654 B80-32925	Pinancing of renewable energy sources /solar, wind and biomass energy sources/
Relevance of the second law of thermodynamics to energy conservation	p0572 A80-49392 Capital requirements for energy in the
[DOB/CS-40178/01-VOL-1] p0590 B80-33288 Photovoltaic technology development for	industrialised countries p0572 180-49393
synchronous orbit p0657 H80-33470 Evaluation of processes for producing gasoline	Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties
from wood [DOB/PE-70048/T2] p0713 H80-33602	p0572 180-49394
Aspects of large area and thin silicon solar cell technologies	Financing of energy investments - Capital and policy requirements of developing countries p0573 A80-49395
p0658 #80-33884 Thin, high efficiency silicon solar cells 56 micrometers thick	The economics of energy prices - Doubts and uncertainty p0573 A80-49396
p0658 N80-33885 Qualification test results of the production high efficiency K6-3/4 and K7 silicon solar cells	Assessment of risks in the financing of major energy projects p0573 A80-49397
p0658 M80-33886 Development of space-qualified Gals solar cells	Trends in financing LHG projects p0573 180-49398
p0658 N80-33888  Comparison of silicon solar cell characteristics at operating temperature after electron	The investment needs of the coal industry of the European Community p0573 A80-49399
irradiation p0659 #80-33890	Financing for energy resources development projects - Japanese experience
BERGY DISSIPATION	p0573 A80-49400
Absolute dissipative drift-wave instabilities in tokamaks p0719 A80-44663	Provision of electric power as a prerequisite and determining factor for safeguarding the industrial community and ensuring the economical
Linear constraints aid selection of lattery charge control parameters for orbiting spacecraft power supplies	development of the Third World p0575 A80-50824

p0769 A80-48400

The investment demand of energy economy and its financing	Carbohydrate crops as a renewable resource for fuels production. Volume 3: Juice preservation
p0575 A80-50827	[BMI-2031-VOL-3] p0696 N80-29511
End-use matching of solar energy systems	Biomass liquefaction efforts in the United States
p0624 A80-51208	[LBL-10456] p0696 H80-29512
Bnergy choices and environmental constraints	Investigation of mechanisms of hydrogen transfer
p0576 A80-51933	in coal hydrogenation
An overview of HASA's participation in the	[FE-2305-33] p0697 N80-29517
nation's energy program	The direct use of coal. Volume 2, part A:
p0625 A80-51950	Working papers, appendices 1-4
Solar opportunities ~ Domestic and international	[PB80-184518] p0697 N80-29520
p0625 A80-51951	The direct use of coal. Volume 2, part B:
World biomass - An overview	Working papers, appendices 7-9
p0687 A80-52852	[FB80-184526] p0697 880-29521
Canadian biomass perspective - A new interest in	The direct use of coal. Volume 2, part C:
an old fuel .	Working papers, appendices 10-14
p0687 A80-52856	[PB80-184534] p0697 H80-29522
European Community's biomass programme	The direct use of coal. Volume 2, part D:
p0687 A80-52859	Working papers, appendices 15-17 p0697 M80-29523
Energy models as a tool for planning p0577 A80-54035	[PB80-184542] p0697 M80-29523 Induced junction solar cell and method of
	fabrication
Chemical and physical stability of refractories	[NASA-CASE-NPO-13786-1] p0634 N80-29835
for use in coal gasification [COO-2904-15] p0690 N80-28478	Alternative metering practices. Implications for
Trace element characterization of coal wastes	conservation in multifamily residences
[PB80-166150] p0577 #80-28488	[HCP/H1693-03] p0579 H80-29838
Alternative Gas Workshop	Minimizing consumption of exhaustible energy
[LA-8155-C] P0690 N80-28547	resources through community planning and design.
Kinetics and mechanisms of catalytic	Development of procedures for application during
hydroliquefaction and hydrogasification of lignite	public facilities procurement process. Phase 2:
[PB-2702-8] p0691 N80-28555	Extension
Liquid-phase methanol	[RLO-2332-3] p0580 #80-29840
[EPRI-AF-1291] p0692 N80-28567	Satellite Power Systems (SPS): Concept
Conversion system overview assessment. Volume 3:	development and evaluation program: Preliminary
Solar thermal/coal or biomass derived fuels	assessent
[SERI/TR-35-078-VOL-3] p0630 N80-28569	[NASA-TH-81142] p0759 N80-29842
Cogeneration Technology Alternatives Study (CTAS).	Solar energy system performance evaluation.
Volume 2: Analytical approach	Seasonal report for Colt Pueblo, Pueblo, Colorado
[NASA-CR-159766] p0741 N80-28859	[NASA-CR-161493] p0635 N80-29850
Solar/hydrogen systems assessment. Volume 1:	Solar energy system performance evaluation. Seasonal report for SERCO Lincoln, Lincoln,
Solar/hydrogen systems for the 1985 - 2000 time frame	Nebraska
[NASA-CR-163392] p0665 N80-28865	[ WASA-CR-161495] p0635 N80-2985
OTEC cold water pipe design for problems caused by	Solar energy system performance evaluation:
vortex-excited oscillations	Seasonal report for Contemporary Newman, Newman,
[AD-A084555] p0741 880-28867	Georgia
Magma energy: A feasible alternative	[NASA-CR-161494] p0635 N80-29853
[SAND-80-0309] p0693 N80-28874	Solar energy system economic evaluation: IBM
Analysis of the influence of geography and weather	System 2, Togus, Maine
on parabolic trough solar collector design	[NASA-CR-161510] p0635 N80-2985
[SAND-79-2032] p0631 N80-28876	Solar energy system performance evaluation:
Environmental data energy technology	Seasonal report for Fern Lansing, Lansing,
characterizations: Coal	Michigan
[DOB/BV-0074] p0577 N80-28882	[NASA-CR-161491] p0635 N80-2985
Regenerative flywheel energy storage system	Solar energy system performance evaluation:
[UCRL-13982-REV-1] p0775 N80-28884	Seasonal report for IBM System 1B, Carlsbad, New Mexico
Design and fabrication of a low cost Darrieus	[NASA-CR-161508] p0635 N80-2985
vertical axis wind turbine system, phase 1 [ALC-4272-T2] p0578 N80-28888	Hydrothermal energy: A source of energy for
Energy savings obtainable through passive solar	alcohol production
techniques	[CONF-800526-1] P0698 H80-2986
[LA-UR-80-746] p0632 N80-28891	Reactively sputtered thin film cu/sub x/S/CdS
Review of the current status of the wind energy	photovoltaic devices
innovative systems projects	[UCID-18592] p0637 N80-2987
[SERI/TP-635-469] p0694 N80-28892	Design of a photovoltaic system for a southwest
Long-term average performance benefits of	all-electric residence
parabolic trough improvements	[SAND-79-7056] p0637 N80-2987
[SERI/TR-632-439] p0632 N80-28893	Standard procedures for terrestrial photovoltaic
Design of land-based, foam OTEC plants for	performance measurements: Specification no. 101
bottoming cycles	[BUR-6423BN] p0637 N80-2987
[CONF-790631-17] p0742 N80-28913	Thin film polycrystalline silicon solar cells
Momentum theory analysis of unconventional wind	[SAN-2207-T4] p0638 N80-2987
extraction schemes, part 10	The 20 percent solar energy goal: Is there a plan
[ASRL-TR-194-2-PT-10] p0742 N80-28932	to attain it? [BHD-80-64] p0638 N80-2988
Safety of wind energy conversion systems (NECS):	[BHD-80-64] p0638 N80-2988 Selection of alternative central-station
Preliminary study risk to personnel and to	technologies for the Satellite Power System
the surrounding area due to mechanical failure [FFA-HU-2126] p0742 M80-28933,	(SPS) comparative assessment
[FFA-BU-2126] p0742 N80-28933, Potential for hydropower development at existing	[DOE/ER-0052] p0580 M80-2988
dams in New England Volume 1: Physical and	Some questions and answers about the Satellite
economic findings and methodology	Power System (SPS)
[PB80-169121] p0578 N80-28934	[ NASA-CR-163329] p0639 N80-2989
Potential for hydropower development at existing	Satellite Power System (SPS) PY 79 program summary
dams in New England. Volume 2: User's manual	[NASA-CR-163479] p0639 N80-2990
[PB80-169139] p0578 N80-28935	Development of sodium sulfur batteries
Outlook for alternative energy sources	[BMFT-FB-T-79-60] p0776 N80-2990
aviation fuels	Development of high temperature resistant, solar
p0694 N80-29302	
	absorber surfaces [BHFT-FB-T-79-70]

p0640 N80-29906

Development of a cadmium selenide thin film solar	
	Hultiphase reactor modeling for zinc chloride
cell [BMFT-FB-T-79-72] p0640 N80-29907	catalyzed coal liquefaction [LBL-9870] p0703 N80-31628
[BMFT-FB-T-79-72] p0640 N80-29907 Nickel hydrogen cell development centered on	[LBL-9870] p0703 R80-31628 Pipeline gas from coal: Hydrogenation (IGT
positive electrodes with high capacity per unit	hydrogasification process)
area for load leveling and traction applications	[PE-2434-33A] p0703 N80-31630
[BMPT-PB-T-79-74] p0776 880-29908	Molten salt coal gasification process development
DOB authorization, 1981, volume 2	unit
[GPO-61-774-VOL-2] p0581 N80-30224	[SAH-1429-56] p0703 H80-31631
Assessment of integrated urban energy options	Possil fuels research matrix program. US
[PB80-173644] p0581 N80-30234	Environmental Protection Agency/Department of
Production of sugarcane and tropical grasses as a	Energy Possil Puels Research Materials Pacility
renewable energy source	[ORNL/TH-7346] p0583 N80-31632
[ORO-5912-T3] p0699 N80-30543 Research and evaluation of biomass	Pittsburgh Energy Technology Center hydrogasification process: Conceptual
resources/conversion/utilization systems	connercial scale plant design
(market/experimental analysis for development of	[DOE/HC-08484/T1] p0703 H80-31633
a data base for a fuels from biomass model)	Advanced coal gasification system for electric
[DOE/ET-20611/11] p0700 880-30552	power generation
Second phase of a coalbed methane extraction and	[FE-1514-101] p0703 B80-31634
utilization program	Cryogenic methane separation/catalytic
[ABSD-THE-3026] p0700 H80-30556	hydrogasification process analysis
Thermophysical properties of coal liquids	[PE-3044-T7] p0704 H80-31635
[BHI-2043] p0701 880-30557 Performance of a diesel engine operating on raw	Advanced development of a short-residence-time
coal-diesel fuel and solvent refined coal-diesel	hydrogasifier [FE-3125-12] p0704 M80-31638
fuel slurries	Advanced development of a short-residence-time
[COBS-3288-T6] p0701 B80-30758	hydrogasifier
Comparative assessment of environmental welfare	[FB-3125-18] p0704 N80-31639
issues associated with the Satellite Power	Chemistry of lignite liquefaction
System (SPS) and alternative technologies	[FE-2211-11] p0704 B80-31642
[DOB/BR-0055] p0581 N80-30915	Liquid fuels from biomass: Catalysts and reaction
Hybrid photovoltaic/thermal systems with a	conditions
solar-assisted heat pump	[LBL-9789] p0705 N80-31646
[BBL-27667] p0642 B80-30919 Controlled cadmium telluride thim films for solar	Economic evaluation of the HIT process for manufacture of ethanol
cell applications (emerging materials systems	[DSE-3992-T1] p0705 N80-31647
for solar cell applications)	Recent coal-oil mixture combustion tests at PRTC
[DOB/ET-23023/T3] p0642 N80-30921	[DOE/PETC-TH-80/5] p0706 N80-31658
Report of the 6th Ocean Thermal Energy Conversion	Energy budget procedures and performance criteria
Conference. Ocean Thermal Energy for the 1980's	for energy conserving building illumination
[COMP-790631-1] p0701 M80-30922	systems
Photovoltaic systems and applications perspective	[PB80-184229] p0583 B80-31673
[SAND-80-0926C] p0582 N80-30923	Small passenger car transmission test; Chevrolet
Design study and economic assessment of multi-unit offshore wind energy conversion systems	LUV transmission [NASA-CR-159882] p0584 N80-31796
application. Volume 1: Executive summary	[HASA-CR-159882] p0584 B80-31796 Solar energy system demonstration project at
1 WASH-2330-18/4-VOL-11 DU /46 NBU-30930	Wilmington Swim School, New Castle, Delaware
[WASH-2330-78/4-V01-1] p0746 M80-30930 Sencenbaugh: Model 1000-14 wind turbine generator	Wilmington Swim School, New Castle, Delaware [NASA-CR-161538] p0644 N80-31878
[WASH-2330-18/4-VOL-1] pu/46 M80-30930 Sencenbaugh: Model 1000-14 wind turbine generator [EFP-3034/3533/79-5] p0746 M80-30931	Wilmington Swim School, New Castle, Delaware [HASA-CR-161538] Solar energy system performance evaluation.
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron	[ MASA-CR-161538] p0644 M80-31878
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery	[HASA-CR-161538] p0644 H80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina
Sencenbaugh: Model 1000-14 wind turbine generator [BFF-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933	[MASA-CR-161538] p0644 B80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [MASA-CR-161546] p0644 B80-31880
Sencenbaugh: Bodel 1000-14 wind turbine generator [RPP-3034/3533/79-5] Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] P0746 880-30933 Puel cells for electric utility and transportation	[MASA-CR-161538] p0644 H80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [MASA-CR-161546] p0644 H80-31880 Solar energy system performance evaluation:
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SMED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications	[NASA-CR-161538] p0644 N80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 N80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite
Sencenbaugh: Model 1000-14 wind turbine generator [BFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Peel cells for electric utility and transportation applications [BML-27452] p0747 M80-30937	[ HASA-CR-161538] p0644 H80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 H80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BNL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system	[NASA-CR-161538] p0644 N80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 N80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California [NASA-CR-161539] p0645 N80-31883
Sencenbaugh: Model 1000-14 wind turbine generator [BFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Peel cells for electric utility and transportation applications [BML-27452] p0747 M80-30937	[ HASA-CR-161538] p0644 H80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 H80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SMED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BML-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30538	[NASA-CR-161538] p0644 N80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 N80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite National Park, California [NASA-CR-161539] p0645 N80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SMED-79-2148C] p0746 M80-30933 Fuel cells for electric utility and transportation applications [BNL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30538 Energy analysis program, FI 1979 [LBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells	[ HASA-CR-161538] p0644 H80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 H80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite National Park, California [ NASA-CR-161539] p0645 N80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 H80-31885
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BML-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30538 Energy analysis program, PY 1979 [IBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-T30] p0643 M80-30946	[ HASA-CR-161538] p0644 H80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 H80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California [ NASA-CR-161539] p0645 H80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 H80-31885 Satellite power systems (SPS) concept definition
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BNL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30538 Energy analysis program, PY 1979 [LBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-T30] Static investigation of rotor blades at rest and	[NASA-CR-161538] p0644 880-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 880-31880 Solar energy system performance evaluation: Seasonal report for Colt Mosemite, Mosemite Hational Park, California [NASA-CR-161539] p0645 880-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 880-31685 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SMED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30538 Energy analysis program, FY 1979 [IBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-730] p0643 M80-30946 Static investigation of rotor blades at rest and under quasi-stationary loading	[ HASA-CR-161538] p0644 H80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 H80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California [ NASA-CR-161539] p0645 H80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 H80-31685 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318]
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BBL-27452] p0747 B80-30937 Thermally driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30538 Energy analysis program, FY 1979 [IBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-T30] p0643 M80-30946 Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] p0747 M80-30948	[ HASA-CR-161538] p0644 H80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 H80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California [ NASA-CR-161539] p0645 N80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOE] p0749 N80-31685 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 H80-31890 Solar energy applications for dwelling: modelling
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30938 Energy analysis program, PY 1979 [LBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-T30] Static investigation of rotor blades at rest and under guasi-stationary loading [ISD-243] p0747 M80-30948 Stability and dynamic response to gravitational	[NASA-CR-161538] p0644 N80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 N80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite National Park, California [NASA-CR-161539] p0645 N80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [N-2595-DOR] p0749 N80-31885 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 N80-31890 Solar energy applications for dwelling: modelling and simulation part
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Fuel cells for electric utility and transportation applications [BNL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] Rnergy analysis program, PY 1979 [LBL-10320] Advanced photovoltaic concentrator cells [DSE-4042-730] Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a	[NASA-CR-161538] p0644 N80-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 N80-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite National Park, California [NASA-CR-161539] p0645 N80-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [N-2595-DOR] p0749 N80-31885  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 N80-31890  Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-EN] p0645 N80-31894
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30938 Energy analysis program, PY 1979 [LBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-T30] Static investigation of rotor blades at rest and under guasi-stationary loading [ISD-243] p0747 M80-30948 Stability and dynamic response to gravitational	[NASA-CR-161538] p0644 880-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 880-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite National Park, California [NASA-CR-161539] p0645 880-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 880-31685 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 880-31890 Solar energy applications for dwelling: modelling and simulation part
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BNL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 Rnergy analysis program, PY 1979 [LBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-730] p0643 M80-30946 Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] p0747 M80-30948 Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] p0747 M80-30949	[ HASA-CR-161538] p0644 H80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 H80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite National Park, California [ NASA-CR-161539] p0645 N80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 N80-31885 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 H80-31890 Solar energy applications for dwelling; modelling and simulation part [ EUR-6681/I-EN] p0645 H80-31894 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SMED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BH-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 Energy analysis program, FI 1979 [IBI-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-730] p0643 M80-30946 Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] p0747 M80-30948 Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] p0747 M80-30949 Dynamic analysis of a rotor blade with lead-lag	[ HASA-CR-161538] p0644 B80-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 M80-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite  Hational Park, California [ NASA-CR-161539] p0645 N80-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 N80-31685  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 N80-31890  Solar energy applications for dwelling; modelling and simulation part [ EUB-6681/I-BB] p0645 N80-31894  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [ DOE/ET-20567/1-2-BK-1] p0645 N80-31896
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 [MBL-27452] p0747 M80-30937 [MBL-27452] p0747 M80-30937 [MBL-10320] p0582 M80-30938 [MBL-10320] p0582 M80-30938 [MBL-10320] p0582 M80-30942 [MBL-10320] p0582 M80-30942 [MBL-10320] p0582 M80-30942 [MBL-10320] p0747 M80-30946 [MBL-10320] p0747 M80-30946 [MBL-10320] p0747 M80-30946 [MBL-10320] p0747 M80-30946 [MBL-10320] p0747 M80-30948 [MBL-10320] p0747 M80-30948 [MBL-10320] p0747 M80-30948 [MBL-10320] p0747 M80-30948 [MBL-10320] p0747 M80-30949 [MBL-1032	[NASA-CR-161538] p0644 880-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 880-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite  Hational Park, California [NASA-CR-161539] p0645 880-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 880-31685  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 N80-31890  Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-ER] p0645 B80-31894  Solar Central Receiver Hybrid Power Systems  sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [DOE/ET-20567/1-2-BK-1]  Solar Central Receiver Hybrid Power Systems
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 N80-30933 Puel cells for electric utility and transportation applications [BNL-27452] p0747 N80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] Renergy analysis program, PY 1979 [LBL-10320] Advanced photovoltaic concentrator cells [DSE-4042-730] Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle	[ NASA-CR-161538] p0644 880-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 880-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite National Park, California [ NASA-CR-161539] p0645 N80-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOE] p0749 N80-31885  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 N80-31890  Solar energy applications for dwelling; modelling and simulation part [ EUR-6681/I-EN] p0645 B80-31894  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [ DOR/ET-20567/1-2-BK-1] p0645 N80-31896  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver Hybrid Power Systems
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SMED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BNL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30938 Energy analysis program, FY 1979 [LBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-730] p0643 M80-30946 Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] p0747 M80-30948 Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] p0747 M80-30949 Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle [ISD-258] p0747 M80-30950	[ HASA-CR-161538] p0644 B80-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 M80-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite  National Park, California [ NASA-CR-161539] p0645 N80-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 N80-31885  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 N80-31890  Solar energy applications for dwelling; modelling and simulation part [ EUR-6681/T-EB] p0645 B80-31894  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [ DOE/ET-20567/1-2-BK-1]  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 Energy analysis program, PY 1979 [LBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-T30] Static investigation of rotor blades at rest and under guasi-stationary loading [ISD-243] p0747 M80-30948 Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] p0747 M80-30949 Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and wariable-controlled blade pitch angle [ISD-258] Regenerative energy sources for the production of	[NASA-CR-161538] p0644 880-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 880-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite  Hational Park, California [NASA-CR-161539] p0645 880-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 880-31885  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 N80-31890  Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-ER] p0645 B80-31894  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [DOE/ET-20567/1-2-BK-1]  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [DOE/ET-20567/1-2-BK-2] p0645 B80-31897
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 N80-30933 Puel cells for electric utility and transportation applications [BNL-27452] p0747 N80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] Renergy analysis program, PY 1979 [LBL-10320] Advanced photovoltaic concentrator cells [DSE-4042-730] Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle [ISD-258] Regenerative energy sources for the production of low temperature heat: Energy sources, energy	[ NASA-CR-161538] p0644 N80-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 N80-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite National Park, California [ NASA-CR-161539] p0645 N80-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ NASA-CR-3018] p0749 N80-31885  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 N80-31890  Solar energy applications for dwelling; modelling and simulation part [ NASA-CR-3318] p0645 N80-31894  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [ NOR/NT-20567/1-2-NK-1] p0645 N80-31896  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [ NOR/NT-20567/1-2-NK-1] p0645 N80-31897  Basic research needs and priorities in solar
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 Energy analysis program, PY 1979 [LBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-T30] Static investigation of rotor blades at rest and under guasi-stationary loading [ISD-243] p0747 M80-30948 Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] p0747 M80-30949 Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and wariable-controlled blade pitch angle [ISD-258] Regenerative energy sources for the production of	[NASA-CR-161538] p0644 880-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 880-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite  Hational Park, California [NASA-CR-161539] p0645 880-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 880-31885  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 N80-31890  Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-ER] p0645 B80-31894  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [DOE/ET-20567/1-2-BK-1]  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [DOE/ET-20567/1-2-BK-2] p0645 B80-31897
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] P0746 M80-30933 Puel cells for electric utility and transportation applications [BNL-27452] P0747 M80-30937 Phermally driven open-cycle heat pump system [CONP-800549-1] Renergy analysis program, PY 1979 [LBL-10320] Advanced photovoltaic concentrator cells [DSE-4042-730] Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle [ISD-258] Regenerative energy sources for the production of low temperature heat: Energy sources, energy types, and energy conversion; results and	[ HASA-CR-161538] p0644 B80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 B80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite National Park, California [ NASA-CR-161539] p0645 N80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 N80-31885 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 N80-31890 Solar energy applications for dwelling; modelling and simulation part [ EUR-6681/I-EN] p0645 N80-31894 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [ DOE/ET-20567/1-2-BK-1] p0645 N80-31896 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [ DOE/ET-20567/1-2-BK-2] p0645 N80-31897 Basic research needs and priorities in solar energy. Volume 1: Executive summary.
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 Permaily driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30938 Penergy analysis program, PY 1979 [LBL-10320] p0582 M80-30942 M40 Photovoltaic concentrator cells [DSE-4042-730] p0683 M80-30946 Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] p0747 M80-30948 Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] p0747 M80-30949 Pynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle [ISD-258] Regenerative energy conversion; results and applications; measures to promote use [ISBM-3-7041-0038-2] p0702 M80-30951 Assessment of the US Mirror Fusion program.	[ HASA-CR-161538] p0644 B80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 B80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite National Park, California [ NASA-CR-161539] p0645 N80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 N80-31885 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 N80-31890 Solar energy applications for dwelling; modelling and simulation part [ EUR-6681/I-EN] p0645 B80-31894 Solar Central Receiver Bybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [ DOE/ET-20567/1-2-BK-1] p0645 N80-31896 Solar Central Receiver Bybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [ DOE/ET-20567/1-2-BK-2] p0645 N80-31897 Basic research needs and priorities in solar energy. Volume 1: Executive summary. Technology crosscuts for DOE [ SERI/TR-351-358-VOL-1] p0645 N80-31898 Sites for wind-power installations: Physical
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 Phermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30937 Phermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 Phermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 Phermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 Phermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 Phermally single possession open p0582 M80-30942 P0582 M80-30942 P0582 M80-30942 P0582 M80-30942 P0582 M80-30942 P0582 M80-30948 P0747 M80-30948 P0747 M80-30948 P0747 M80-30948 P0747 M80-30948 P0747 M80-30949	[NASA-CR-161538] p0644 880-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 880-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California [NASA-CR-161539] p0645 880-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 880-31885 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 N80-31890 Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-ER] p0645 B80-31894 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [DOE/ET-20567/1-2-BK-1] Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [DOE/ET-20567/1-2-BK-2] p0645 B80-31897 Basic research needs and priorities in solar energy. Volume 1: Executive summary. Technology crosscuts for DOE [SEBI/TR-351-358-VOL-1] p0645 B80-31898 Sites for wind-power installations: Physical modeling of the influence of hills, ridges and
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 N80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 N80-30933 Puel cells for electric utility and transportation applications [BNL-27452] p0747 N80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] p0582 N80-30938 Renergy analysis program, PY 1979 [LBL-10320] p0582 N80-30942 Advanced photovoltaic concentrator cells [DSE-4042-T30] p0643 N80-30946 Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] p0747 N80-30948 Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] p0747 N80-30949 Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle [ISD-258] p0747 N80-30950 Regenerative energy sources for the production of low temperature heat: Energy sources, energy types, and energy conversion; results and applications: measures to promote use [ISB-3-7041-0038-2] p0702 N80-30951 Assessment of the US Mirror Fusion program. Report of the 1980 Mirror Senior Review Panel [DOE/EE-0057]	[ NASA-CR-161538] p0644 880-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 880-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite National Park, California [ NASA-CR-161539] p0645 880-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 880-31885  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 880-31890  Solar energy applications for dwelling; modelling and simulation part [ EUR-6681/I-BN] p0645 880-31894  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [ DOE/ET-20567/1-2-BK-1] p0645 880-31896  Solar Central Receiver Bybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [ DOE/ET-20567/1-2-BK-1] p0645 880-31897  Basic research needs and priorities in solar energy. Volume 1: Executive summary. Technology crosscuts for DOE [ SERI/TR-351-358-VOL-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BNL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30538 Rnergy analysis program, PY 1979 [LBL-10320] p0582 M80-30942 Advanced photovoltaic concentrator cells [DSE-4042-730] p0643 M80-30946 Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] p0747 M80-30948 Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] p0747 M80-30949 Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle [ISD-258] p0747 M80-30950 Regenerative energy sources for the production of low temperature heat: Energy sources, energy types, and energy conversion; results and applications; measures to promote use [ISBN-3-7041-0038-2] p0702 M80-30951 Assessment of the US Mirror Fusion program. Report of the 1980 Mirror Senior Review Panel [DOE/ER-0057] p0748 M80-31214	[NASA-CR-161538] p0644 880-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 880-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California [NASA-CR-161539] p0645 880-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 880-31885 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 880-31895 Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-EN] p0645 880-31894 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [DOR/ET-20567/1-2-BK-1] p0645 880-31896 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [DOR/ET-20567/1-2-BK-2] p0645 880-31897 Basic research needs and priorities in solar energy. Volume 1: Executive summary. Technology crosscuts for DOE [SERI/TR-351-358-VOL-1] Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Fart 1: Executive summary
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 [Mermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 [Mermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 [Mermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30942 Mayanced photovoltaic concentrator cells [DSE-4042-T30] p0582 M80-30946 [Mermally static investigation of rotor blades at rest and under guasi-stationary loading [ISD-243] p0747 M80-30948 [ISD-243] p0747 M80-30948 [ISD-244] p0747 M80-30949 [ISD-244] p0747 M80-30949 [ISD-244] p0747 M80-30949 [ISD-244] p0747 M80-30949 [ISD-258] p0747 M80-30949 [ISD-258] p0747 M80-30950 [ISD-258] Regenerative energy sources for the production of low temperature heat: Energy sources, energy types, and energy conversion; results and applications; measures to promote use [ISBN-3-7041-0038-2] p0702 M80-30951 [ISBN-3-7041-0038-2] p0702 M80-30951 [ISBN-3-7041-0038-2] p0748 M80-31214 [ISD-258] p0748 M80-31214 [ISD-258] p0748 M80-31214 [ISD-257] p0748 M80-31214 [ISD-258] p0768	[NASA-CR-161538] p0644 880-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 880-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California [NASA-CR-161539] p0645 880-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 880-31885 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 N80-31890 Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-ER] p0645 B80-31894 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [DOE/ET-20567/1-2-BK-1] Solar Central Receiver Bybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [DOE/ET-20567/1-2-BK-2] p0645 B80-31897 Basic research needs and priorities in solar energy. Volume 1: Executive summary. Technology crosscuts for DOE [SERI/TR-351-358-VOL-1] p0645 B80-31898 Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [ELO-2438-78/1] p0706 B80-31900
Sencenbaugh: Model 1000-14 wind turbine generator [RPF-3034/3533/79-5] Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] P0746 N80-30933 Puel cells for electric utility and transportation applications [BNL-27452] P0747 N80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] Renergy analysis program, PY 1979 [LBL-10320] Advanced photovoltaic concentrator cells [DSE-4042-730] Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle [ISD-258] Regenerative energy sources for the production of low temperature heat: Energy sources, energy types, and energy conversion; results and applications; measures to promote use [ISBN-3-7041-0038-2] Assessment of the US Mirror Fusion program. Report of the 1980 Mirror Senior Review Panel [DOE/ER-0057] Study of hydrogen-powered versus battery-powered automobiles [ATB-79 (7759)-1-VOL-1]	[ NASA-CR-161538] p0644 880-31878  Solar energy system performance evaluation.  Seasonal report for Wormser, Columbia, South Carolina [ NASA-CR-161546] p0644 880-31880  Solar energy system performance evaluation:  Seasonal report for Colt Yosemite, Yosemite National Park, California [ NASA-CR-161539] p0645 N80-31883  A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [ R-2595-DOR] p0749 N80-31885  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [ NASA-CR-3318] p0760 N80-31890  Solar energy applications for dwelling; modelling and simulation part [ EUR-6681/I-EN] p0645 N80-31894  Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [ DOE/ET-20567/1-2-BK-1] p0645 N80-31896  Solar Central Receiver Bybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [ DOE/ET-20567/1-2-BK-1] p0645 N80-31896  Solar Central Receiver Bybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [ DOE/ET-20567/1-2-BK-1] p0645 N80-31897  Basic research needs and priorities in solar energy. Volume 1: Executive summary. Technology crosscuts for DOE [ SERI/TR-351-350-VOL-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [ ELO-2438-78/1] p0706 N80-31900
Sencenbaugh: Model 1000-14 wind turbine generator [RPP-3034/3533/79-5] p0746 M80-30931 Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BHL-27452] p0747 M80-30937 [Mermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 [Mermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30938 [Mermally driven open-cycle heat pump system [CONP-800549-1] p0582 M80-30942 Mayanced photovoltaic concentrator cells [DSE-4042-T30] p0582 M80-30946 [Mermally static investigation of rotor blades at rest and under guasi-stationary loading [ISD-243] p0747 M80-30948 [ISD-243] p0747 M80-30948 [ISD-244] p0747 M80-30949 [ISD-244] p0747 M80-30949 [ISD-244] p0747 M80-30949 [ISD-244] p0747 M80-30949 [ISD-258] p0747 M80-30949 [ISD-258] p0747 M80-30950 [ISD-258] Regenerative energy sources for the production of low temperature heat: Energy sources, energy types, and energy conversion; results and applications; measures to promote use [ISBN-3-7041-0038-2] p0702 M80-30951 [ISBN-3-7041-0038-2] p0702 M80-30951 [ISBN-3-7041-0038-2] p0748 M80-31214 [ISD-258] p0748 M80-31214 [ISD-258] p0748 M80-31214 [ISD-257] p0748 M80-31214 [ISD-258] p0768	[NASA-CR-161538] p0644 N80-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 N80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California [NASA-CR-161539] p0645 N80-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 N80-31885 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 N80-31890 Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-EN] p0645 N80-31894 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [DOE/ET-20567/1-2-BK-1] Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [DOE/ET-20567/1-2-BK-2] p0645 N80-31897 Basic research needs and priorities in solar energy. Volume 1: Executive summary. Technology crosscuts for DOE [SERI/TR-351-358-VOL-1] p0645 N80-31898 Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [ELO-2438-78/1] p0706 N80-31900
Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery [SAED-79-2148C] p0746 M80-30933 Puel cells for electric utility and transportation applications [BNL-27452] p0747 M80-30937 Thermally driven open-cycle heat pump system [CONP-800549-1] Renergy analysis program, PY 1979 [LBL-10320] Advanced photovoltaic concentrator cells [DSE-4042-730] Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle [ISD-258] Regenerative energy sources for the production of low temperature heat: Energy sources, energy types, and energy conversion; results and applications; measures to promote use [ISBN-3-7041-0038-2] Assessment of the US Mirror Pusion program. Report of the 1980 Mirror Senior Review Panel [DOE/ER-0057] Study of hydrogen-powered versus hattery-powered automobiles [ATB-79(7759)-1-VOL-1] A study of industrial hydrogen and syngas supply	[NASA-CR-161538] p0644 880-31878 Solar energy system performance evaluation. Seasonal report for Wormser, Columbia, South Carolina [NASA-CR-161546] p0644 880-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite Hational Park, California [NASA-CR-161539] p0645 880-31883 A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOR] p0749 880-31885 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 880-31890 Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-EN] p0645 880-31894 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4 [DOR/ET-20567/1-2-BK-1] p0645 880-31896 Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [DOR/ET-20567/1-2-BK-2] p0645 880-31897 Basic research needs and priorities in solar energy. Volume 1: Executive summary. Technology crosscuts for DOE [SERI/TR-351-358-VOL-1] Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [ELO-2438-78/1] p0706 880-31900 Sites for wind-power installations: Wind characteristics over ridges, part 2

	•
Investigation of learning and experience curves	Economics of shale oil production by radio
[SEBI/TE-353-459] p0646 B80-31911	frequency heating
Energy analysis of geothernal-electric systems	[UCBL-52942] p0710 N80-32566
[COO-5085-4] p0584 N80-31915	Assessment of Synthane mechanical equipment
Material-flow data structures as a basis for energy information system design	[HTI-79TR5] p0710 H80-32572 Coal liquefaction
[LBL-10248] p0760 #80-31923	[DOE/FE-0003/79-2] p0711 880-32574
Analytical modeling of line focus solar collectors	UTRC 8 kW wind turbine tests
[SBBI/TP-333-591] p0647 H80-31926	[RPP-3085] p0752 N80-32722
Solar energy conversion through biophotolysis	Design and development of Stirling engines for
[SAB-0034-239-1-T2] p0666 H80-31927  Blectrolysis-based bydrogen storage technology	stationary power generation applications in the 500 to 3000 horsepower range
[BHL-26923] p0647 N80-31928	[DOB/RT-15207/T1] p0752 N80-32723
Federal demonstrations of solar heating and	Mean wind forces on parabolic-trough solar
cooling on commercial buildings have not been	collectors
very effective	[SAND-80-7023] p0650 N80-32790
[END-80-41] p0750 N80-31929 Summary of guidelines for siting wind turkine	Solar hot water demonstration project at Red Star Industrial Laundry, Fresno, California
generators relative to small-scale,	[NASA-CE-161537] p0650 N80-32851
two-dimensional terrain features	Large wind turbines: A utility option for the
[RLO-2443-77/1] p0647 H80-31930	generation of electricity
Solar assisted heat pump studies: Heat pump	[NASA-TM-81502] p0752 N80-32858
hardware and experiments, simulations, Earth coupling contracts and supporting contracts	Open-cycle MHD power conditioning and control requirements definition
[BNL-27668] p0647 N80-31933	[EPRI-AP-1345] p0752 N80-32864
AC/DC power converter for batteries and fuel cells	Combined cycle solar central receiver hybrid power
[EPRI-RM-1286] p0750 M80-31937	system study. Volume 1: Executive summary
Development of molten carbonate fuel cell power	[DOB/RT-21050/1-1] p0586 N80-32867
plant technology [DOE/ET-15440/1] p0750 N80-31938	Combined cycle solar central receiver hybrid power system study, volume 2
Assessment of industrial energy conservation by	[DOB/RT-21050/1-2] p0586 N80-32868
unit processes	Porous media experience applicable to field
[ORAU/IBA-80-4 (M)] p0584 M80-31939	evaluation for compressed air energy storage
Residential solar heating and cooling using	[PNL-3294] p0777 N80-32873
evacuated tube solar collectors: CSU Solar House 3, executive summary	Residential photovoltaic flywheel storage system performance and cost
[COO-2858-24] p0647 880-31941	[DOE/ET-20279/92] p0587 N80-32874
Terrestrial photovoltaic power systems with	Advanced technology fuel cell program
sunlight concentration	[EPRI-BM-1328] p0752 N80-32877
[SAND-80-7008] p0648 N80-31942	Reference energy systems as applied to regional
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation	energy policy [BNL-26987] p0587 N80-32883
[ATR-80 (7773-03) -1-VOL-2] p0648 H80-31944	Planning for electric utility solar applications:
Continued evaluation of compact heat exchangers	The effects on reliability and production cost
for OTEC evaluation	estimates of the variability in demand
[COO-4238-14] p0750 N80-31945	[SERI/TP-351-545] p0587 N80-32888
Ocean energy systems: Multiyear program plan [DOE/CS-0161] p0707 H80-31946	Design and fabrication of combined photovoltaic-thermal collectors
Photovoltaic institutional issues study	[SAND-79-7008] p0652 H80-32890
[SAND-79-7054] p0584 N80-31950	Photovoltaic applications definition and
Photoelectrochemical solar cells based on d-band	photovoltaic system definition study in the
electrochemistry at transition metal diselenides	agricultural sector. Volume 3. Appendixes
[IS-4724] p0648 N80-31952 Low cost solar cells based on amorphous silicon	[SAND-79-7018/3] p0652 M80-32891 Solar powered rankine cycle irrigation pump
electrodeposited from organic solvents	[DOB/ET-20419/1] p0652 N80-32892
[SAN-0113-040-T6] p0648 N80-31953	Combined cycle solar central receiver hybrid power
Gallium arsenide solar cells for very high	system study. Volume 3: Appendices
concentration systems: Recent results, problems	[DOE/ET-21050/1-3-VOL-3] p0587 N80-32893
and expectations [CISE-1518] p0649 N80-31962	Costing methodologies for energy systems [BNL-27603] p0778 M80-32900
Wind power. Citations from the NTIS data base	Economic evaluation of the Annual Cycle Energy
[PB80-811458] p0751 N80-31965	System (ACES). Volume 1: Executive summary
Interactions between energy supply and	[ORNL/SUB-7470/1-V1] p0587 N80-32905
transportation-related energy use, volume 1 [PB80-185002] p0584 M80-31968	Energy and technology review p0588 N80-32909
Pollutants from synthetic fuels production: Coal	Monitoring of the performance of a solar heated
gasification screening test results	and cooled apartment building
[PB80-182769] p0707 N80-31986	[DSE-5235-T1] p0653 N80-32913
Review of Department of Energy sponsored codes and	Investigation of low-cost solar cells based on Cu20
documentation available from Purdue and Lehigh Universities processes modeling contracts	[DOE/ET-23006/3] p0653 N80-32915 Development of the zinc-chloride battery for
[K/CSD/TM-35] p0707 N80-32278	utility applications
Example of a policy aimed at increasing the value	[EPRI-RM-1417] p0778 N80-32917
of spin-offs from space technology in other fields	International energy indicators
[SNIAS-801-422-101] p0762 N80-32297 Assessment of Peruvian biofuel resources and	[DOE/IA-0010] p0588 N80-32918 CdSiAs2 thin films for solar cell applications
alternatives	[DOE/ET-23007/1] p0653 N80-32919
[ANL/ERS/TM-86] p0708 N80-32547	Deposition, fabrication and analysis of
First report to Congress on the use of alcohol in	polycrystalline silicon MIS solar cells
motor fuels	[DOE/BT-23044/4] p0653 N80-32920
[DOB/CS-0165] p0708 M80-32548 Hydrogen production from remote power sites	Amorphous thin films for solar-cell applications [DOE/ET-21074/4] p0653 N80-32921
[BNI-27457] p0666 N80-32553	Assessment of hydrogen compressor technology for
Kinetics and mechanisms of catalytic	energy storage and transmission systems
hydroliquefaction and hydrogasification of lignite	[ORO-5598-T1] p0667 N80-32922
[FE-2702-10] p0709 M80-32556	Solar index generation and delivery
California's biomass and its energy potential [LBL-10058] p0709 N80-32564	[DOE/RT-20090/3] p0654 N80-32929
, pores nos 32304	

Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon. Pulsed power accelerators for particle beam fusion .p0715 N80-34239 [SAND-80-0550C] EBERGY REQUIREMENTS impact program [DOE/CH-00178/T2] p0654 H80-32934 Neutral-beam energy and power requirements for expanding-radius and full-bore start-up of Gallium arsenide photovoltaic dense array for concentrator applications [SAND-80-1569C] tokamak reactors p0654 N80-32936 n0719 A80-44656 Thermographic techniques applied to solar Autonomous solar-electric systems collector systems analysis
[SERI/TP-351-540]
Solar ponds and their applications p0596 A80-45477 The potential global market in 2025 for Satellite Solar Power Stations p0655 N80-32946 [SERI/TP-733-617] p0655 N80-32947 p0598- A80-46382 Performance of storage walls with highly Prospects for using solar energy to power naterials-science furnaces in space conductive covering plates and connecting films
[SERI/TP-721-574] p0779 N80-32948
Computer modeling of thermal storage walls p0599 A80-46688 Energy choices for the 1980s [SERI/TP-721-610] p0779 #80-32949 p0570 A80-47099 Concentrating photovoltaics for the tropics [DOD/CS-04270/1] p0556 880-32:
Development of an 8 kW wind turbine generator for residential type application. Phase 1: Design Energy from MSW - The industrial market p0656 N80-32954 Municipal Solid Waste p0670 A80-47588 Wood energy systems - An assessment and analysis. Volume 1: Executive summary [DOE/DP-03533/T1-VOL-1] p0753 H80-32957 Appraisal of the M factor and the role of building p0670 A80-47593 Energy from wood waste. - A case study p0670 A80-47594 thermal mass in energy conservation Utilization of solar radiation for water photolysis p0588 N80-32958 [ORNL/CON-46] p0661 A80-47667 Assessment of environmental control technologies Sodium-sulfur load leveling battery system for energy storage systems, 1979 p0764 A80-48235 [LA-8308-HS] p0588 N80-32973 High voltage power systems for military needs -Environmental assessment. Energy efficiency standards for consumer products solar energy conversion equipment p0725 A80-48254
The role of refuse derived fuel /RFD/ as an
alternative energy source for district heating [DOE/CS-0168] p0589 N80-32988 Environmental-control-technology activities of the Department of Energy in FY 1979 and power generation [DOB/EV-0084] p0675 A80-48331 p0589 N80-32989 Basic Research in Engineering: Process and Systems Dynamics and Control. High Priority Research Needs Relevant to Energy Experimental and theoretical studies of thermal energy storage in aquifers p0766 A80-48334 An energy and cost analysis of residential heat pumps in northern climates [FB-2468-65] p0590 N80-33167 Optimal thermionic energy conversion with established electrodes for high-temperature topping and process beating --- coal combustion product environments p0571 A80-48426 The Department of Energy's major project coal liquefaction program [NASA-TH-81555] p0677 A80-48427 p0754 N80-33221 Development and application of analytical techniques to chemistry of donor solvent Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program liquefaction [DOE/PC-20041/T1] p0712 N80-33520 p0677 .180-48428 Oversight: Alternate liquid fuels technology H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal p0677 A80-48429 emerging synthetic fuels technology, volume 9 [GPO-51-721] p0590 N80-33581 Exxon Donor Solvent Coal Liquefaction Process Development Program Status Solar heating system at Quitman County Bank, p0677 A80-48430 Marks, Mississippi [NASA-CR-161549] Heating requirements and estimations of solar energy available in Iran p0657 N80-33858 Cogeneration Technology Alternatives Study (CTAS).
Volume 6: .Computer data. Part 1: Coal-fired p0620 A80-48792 Financing of renewable energy sources /solar, wind nocogeneration process boiler, section A [NASA-CR-159770-PT-1] p0591 and biomass energy sources/ Cogeneration Technology Alternatives Study (CTAS).

Volume 6: Computer data. Part 2:

Besidual-fired nocogeneration p0572 A80-49392 Capital requirements for energy in the industrialised countries Residual-fired nocogeneration process boiler [NASA-CE-159770-PT-2] p0591 N80 p0572 A80-49393 p0591 N80-33861 Capital requirements for the development in the field of energy in the Eastern European Installation, operation, and maintenance for the pyramidal optics solar system installed at Yacht Cover, Columbia, South Carolina [NASA-CR-161203] p0657 N80-338 countries on the eve of the nineties p0572 180-49394 Pinancing of energy investments - Capital and p0657 N80-33864 Supply and demand alternatives Energy policy: [GPO-56-541] policy requirements of developing countries p0591 N80-33870 p0573 A80-49395 Oversight: Wind energy program [GPO-51-382] Assessment of risks in the financing of major p0591 N80-33872 energy projects Photovoltaic generators in space p0573 A80-49397 conference proceedings, Heidelberg, 15-17 Apr. 1980 [ESA-SP-147] p0658 The investment needs of the coal industry of the p0658 N80-33873 European Community Impact of terrestrial solar cell development on p0573 A80-49399 space applications Impact of electric cars on U.S. petroleum D0659 N80-33893 CODSUMPTION Satellite power systems: Status and planned [ SAB PAPER 800108 ] p0773 A80-49726 Biberonnage makes an electric car practical with p0760 N80-33904 existing batteries --- recharging during periods The potential of energy farming in the southeastern California desert of non-use [ SAE PAPER 800204 ] p0773 A80-49731 [PB80-195019] p0714 N80-33921 Solar and wind energy - Its contribution to meeting future power requirements Conservation and solar energy programs of the Department of Energy: A critique p0623 A80-50816 [PB80-197759] p0591 ¥80-33922 Energy expenditure for environmental protection -Environment: The energy connection

p0592 N80-33955

A contribution to efficiency analysis

P0575 A80-50819 '

SUBJECT INDEX BEERGY STORAGE

An analysis of criteria for evaluating proposals for recovery of material and energy from refuse p0574 &80-49931 The significance of the gas economy from the viewpoint of environmental protection p0575 A80-50821 Ensured power supply and environmental protection Combustible briquets from waste using the as elements of a provident social policy
p0575 A80-50825
Increased information acquisition and transmission PINEDA/LOAS process p0683 A80-50009 Strategies for rational utilization of bituminous as a condition for the further development of coal deposits in the German Pederal Republic p0685 A80-50814 energy economy structures Power generation from municipal and industrial wastes with particular reference to sewage p0575 A80-50826 The investment demand of energy economy and its combustion p0685 A80-50815 p0575 A80-50827 Solar and wind energy - Its contribution to meeting future power requirements End-use matching of solar energy systems p0624 A80-51208
The technical and economic aspects of brown coal D0623 A80-50816 The significance of the gas economy from the viewpoint of environmental protection D0686 A80-51498 DOB view of solar power commercialization and p0575 A80-50821 applications The usefulness of 'alternative' energy sources p0629 A80-52870 from the economic and energetic point of view p0685 A80-50823
Increased information acquisition and transmission U.S. Department of Energy ccean waves and ocean currents energy conversion programs - An overview p0740 A80-53678 as a condition for the further development of Worldwide transportation/energy demand, 1975-2000: Bevised Variflex Bodel projections energy economy structures p0575 A80-50826 [ORNL/SUB-79/45740/1] p0578 N80-28915 Biomass for energy --- Book Energy economic projections for the 1979 overview [EPRI-PS-79-5-LD] p0578 N80-28 D0687 A80-52851 p0578 N80-28918 World biomass - An overview Comparative assessment of five long-run energy p0687 A80-52852 projections Biomass - Puture developments p0582 N80-30936 DOE/BIA/CR-0016/02] p0687 A80-52858 Solar Central Receiver Hybrid Power Systems European Community's biomass programme sodium-cooled receiver concept. Volume 2, book p0687 A80-52859 1: Conceptual design, sections 1 through [DOE/RT-20567/1-2-BK-1] p0645 R
Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, The remaissance of coal --- prospects and problems p0645 N80-31896 of increased worldwide utilization p0689 A80-54036 Documentation of volume 3 of the 1978 Energy sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6 [DOE/ET-20567/1-2-BK-2] p0645 N80-318 Planning for electric utility solar applications: The effects on reliability and production cost estimates of the variability in demand [SERI/TP-351-5451 Information Administration annual report to p0645 N80-31897 congress [DOE/BIA/CR-0456] p0782 N80-32869 · NASA technology program overview p0782 N80-33467 [ SBRI/TP-351-545 ] p0587 N80-32888 Municipal refuse as a fuel for power generation p0714 N80-33950 Deep space network energy program p0590 N80-33446 Utilization of municipal refuse as an energy source Oversight: Cost estimation techniques for p0714 N80-33952 emerging synthetic fuels technology, volume 9
[GPO-51-721] p0590 N80-REPRET STORAGE p0590 N80-33581 Hydrogen in metals - Outstanding properties and BEERGY SOURCES examples for utilization. II High temperature heat pump applications -Commercial, industrial, and with alternative energy sources p0661 A80-43842 Hydrogen storage in a beryllium substituted TiPe COMPOUND P0670 A80-47590 Structures, reduction potentials and absorption maxima of synthetic dyes of interest in Peat and wood as fuels - Another form of solar energy utilization p0671 A80-47595 photochemical solar-energy storage studies Solar retorting of oil shale p0595 A80-45314 p0613 A80-48198 Computer aided optimal design of compressed air Analysis of small, nonconventional electric power energy storage systems systems for remote site applications p0761 A80-45826 p0765 A80-48272 A system consideration of alternative hydrogen Alternatives for heat supply in biomass energy storage facilities for estimation of storage costs conversion systems p0661 A80-47666 p0673 A80-48277 Chemical Energy Storage for Solar Thermal Blectric Kelp processing and biomethanation technology p0673 A80-48278 Conversion p0763 A80-48195 Municipal solid waste and district heating - A Solar/electric district heating via CASES --Community Annual Storage Energy Systems case study p0727 A80-48285 p0616 A80-48286 Development status and utility of the sulfuric acid chemical heat pump/chemical energy storage Wind resource assessment in the upper Skagit River Valley of Washington p0675 A80-48319 p0765 A80-48288 Engineering prototype studies on the CaCl2-CH30H chemical heat pump for solar air conditioning, heating, and storage Potential for biological conversion of biomass to liquid fuels p0675 A80-48323 Fermentation ethanol as a retroleum substitute p0675 180-48324 p0616 A80-48289 · The economics of aguifer storage of chilled water Perspective on the DOE fusion synthetic fuels for air conditioning program p0677 A80-48402 p0767 A80-48337 Development of a compressed air energy storage power generation plant - The PEFCO demonstration Pinancing of renewable energy sources /solar, wind and biomass energy sources/ p0572 A80-49392 plant study Financing for energy resources development p0767 A80-48338 The economics of compressed air energy storage with thermal energy storage projects - Japanese experience p0573 A80-49400 Rnergy and material recycling p0767 A80-48339 p0680 A80-49927

EMERGY TECHNOLOGY SUBJECT INDEX

	•
The new age of high performance kinetic energy storage systems	Development of molten carbonate fuel cell power plant technology
p0768 A80-48374	[DOE/RT-15440/1] p0750 N80-31938
Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage	Brample of a policy aimed at increasing the value of spin-offs from space technology in other fields [SNIAS-801-422-101] p0782 880-32297
p0768 A80-48375 Coal-fired fluid bed combustion augmented	Modeling and evaluation of designs for solid hydrogen storage beds
compressed air energy storage systems	[CONP-800616-8] p0666 B80-32554
p0768 A80-48376 Residential photovoltaic flywheel storage system performance and cost	Solar hot water demonstration project at Red Star Industrial Laundry, Fresno, California [BASA-CR-161537] p0650 B80-32851
p0768 A80-48377 Plywheel-transmission characteristics required for break-even impact on automotive vehicle performance	A study of the applicability/compatibility of inertial energy storage systems to future space missions [NASA-CR-163584] p0777 N80-32856
p0768 A80-48378 Photo-intercalation - Possible application in	Energy storage as heat-of-fusion in containerized salts. Beport on energy storage boiler tank
solar energy devices	[AD-A087753] p0777 880-32862
p0620 A80-48548 Hydrogen storage in magnesium powder	Porous media experience applicable to field evaluation for compressed air energy storage
p0664 A80-50623 Community Annual Storage Energy System	[PNL-3294] p0777 #80-32873 Residential photovoltaic flywheel storage system
p0773 A80-50910 Energy Conservation with flywheels	performance and cost [DOE/RT-20279/92] p0587 #80-32874
p0773 A80-50911	Advanced technology fuel cell program
A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs	[RPRI-EM-1328] p0752 H80-32877 Chemical energy storage for solar thermal conversion
p0624 A80-50968 A new probabilistic simulation technique for	[SAND-79-8198] p0652 N80-32889 Low-cost flywheel demonstration program
multiple energy storage devices for electric utility generation system expansion planning	[DOE/RT-26931/T1] p0778 #80-32897 Research and development for inertial energy
models	storage based on a flexible flywheel
p0774 M80-28855 Multiple-tank high temperature storage subsystem	[SAND-79-7097] p0778 N80-32898 Development of the zinc-chloride battery for
[SAND-79-2056] p0775 H80-28878 Regenerative flywheel energy storage system	utility applications [EPRI-EE-1417] p0778 B80-32917
[UCBL-13982-BEV-1] p0775 N80-28884	Assessment of hydrogen compressor technology for
Organic photochemical storage of solar energy [COO-4380-3] p0632 M80-28905	energy storage and transmission systems [OBO-5598-T1] p0667 H80-32922
Solar energy system performance evaluation: Seasonal report for Contemporary Newman, Newman,	Solar gasification of charcoal, wood and paper [UCBL-84411] p0654 B80-32926
Georgia [NASA-CB-161494] p0635 N80-29853	Analysis of aluminum-air battery propulsion systems for passenger vehicles
Solar energy system performance evaluation:	[UCRL-83824] p0778 H80-32940
Seasonal report for Pern Lansing, Lansing, Michigan	Performance of storage walls with highly conductive covering plates and connecting films
[NASA-CR-161491] p0635 N80-29855 Solar energy system performance evaluation:	[SERI/TP-721-574] p0779 B80-32948 Computer modeling of thermal storage walls
Seasonal report for IBM System 1B, Carlsbad, New Mexico	[SERI/TP-721-610] p0779 #80-32949 Model of direct contact heat transfer for latent
[NASA-CR-161508] p0635 H80-29856 Blectrochemical energy storage systems for solar	heat energy storage [SERI/TP-631-567] p0779 H80-32955
thermal applications	Proceedings of the Clemson Workshop on
Hydrogen storage: Hydrogen as a hydride.	Environmental Impacts of Pumped Storage Hydroelectric Operations
Citations from the NTIS data base [PB80-811094] p0665 N80-30561	[PB80-192453] p0588 B80-32964 Lithium batteries. Citations from the Engineering
Sulfuric acid and water chemical heat pump/chemical energy storage program, phase 2-A	Index data base [PB80-812407] p0779 #80-32968
[SAND-78-8176] p0776 B80-30924	Assessment of environmental control technologies
System design, tests results, and economic analysis of a flywheel energy storage and	for energy storage systems, 1979 [LA-8308-BS] p0588 N80-32973
conversion system for photovoltaic applications [COO-4094-70] p0746 H80-30928	Electrochemical Orbital Energy Storage (ECOES) technology program regenerative fuel cell
Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery	system p0780 #80-33473
[SAND-79-2148C] p0746 N80-30933	Low-cost flywheel demonstration program
Puel cells for electric utility and transportation applications	[CONS-5085-T2] p0780 H80-33909 EMERGY TECHNOLOGY
[BNL-27452] p0747 M80-30937 Wind power. Citations from the MTIS data base	Issues in OTEC commercialization p0719 A80-44606
[PB80-811433] p0748 N80-30956	Introducing OTEC to mainland utilities
Wind power. Citations from the Engineering Index data base	p0719 A80-44607 Setting fire to the whole forest Belgian
[PB80-811441] p0748 M80-30957 Automotive storage of hydrogen using modified	energy policy p0569 180-44780
magnesium hydrides [SAB-1167-1] p0666 B80-31650	The U.S. coal gasification program - Progress and projects
High energy density composite flywheel program	p0670 A80-46325
Blectrolysis-based bydrogen storage technology	Mid-range energy forecasting system - Structure, forecasts, and critique
[BNI-26923] p0647 R80-31928 Solar assisted heat pump studies: Heat pump	p0570 A80-46335 The benefits of solar power satellites
hardware and experiments, simulations, Earth coupling contracts and supporting contracts	p0598 A80-46387 Technology and economics of starting materials for
[BHL-27668] p0647 H80-31933	low-cost silicon solar cells

p0598 180-46387
Technology and economics of starting materials for low-cost silicon solar cells

p0600 A80-46698

	Potential for conversion of refuse to energy in
Requirements for future Air Force satellite solar power technology p0604 A80-46736	Ontario Canada and the Provincial Energy from Waste program
Numerical modelling of a solar cell in three dimensions	p0681 A80-49946 Bnergy recovery from solid waste for city of Tehran
P0605 A80-46749	p0681 A80-49948
High efficiency silicon solar cell for concentrator systems	A refuse incineration plant in combination with district heating demonstrated by the Iserlohn
p0606 A80-46767	Plant
Hybrid system consisting of silicon solar cells with concentrators and heat pump	p0681 A80-49964 Recent developments in a slagging process for
p0608 A80-46792	conversion of refuse to energy
Description of photovoltaic village power systems	p0682 A80-49981
in the United States and Africa p0609 A80-46796	Brini - A completion to solid fuels municipal solid wastes conversion
Energy choices for the 1980s p0570 A80-47099	p0684 A80-50017 Solaser power solar energy lasing in space
The case for fuel-cell-powered vehicles p0721 A80-47100 Alternate synthesis of electrolyte matrix for	p0622 180-50627 Geothermal energy - An overview p0737 180-50907
molten carbonate fuel cells p0721, A80-47135	Energy conservation with flywheels p0773 A80-50911
Solar cells for terrestrial applications p0611 180-47156	Energy conservation and solar houses p0623 A80-50941
Preliminary results from the shrouded wind-turbine	The technical and economic aspects of brown coal
pilot plant	refinement
p0722 A80-47525	p0686 A80-51498
Energy utilization: World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31,	An overview of NASA's participation in the nation's energy program
1979, Compiled Papers p0570 A80-47585	p0625 A80-51950 Alcohol fuels for spaceship earth
Energy to the 21st century; Proceedings of the	p0686 A80-51953
Fifteenth Intersociety Energy Conversion	National Passive Solar Conference, 3rd, San Jose,
Engineering Conference, Seattle, Wash., August 18-22, 1980. Volumes 1, 2 and 3	Calif., January 11-13, 1979, Proceedings p0626 A80-52826
p0722 A80-48165	Biomass for energy Book
Progress in space power technology	p0687 A80-52851
p0722 A80-48173 Solar thermophotovoltaic space power system	World biomass - An overview p0687 A80-52852
p0614 A80-48208	Biomass - Future developments
U.S./U.S.S.R. joint MHD generator testing at the U-25 MHD pilot plant	p0687 A80-52858 Photovoltaic solar energy conversion: Proceedings
p0724 A80-48223	of the Conference, London, England, September
Status cf peat biogasification development p0674 A80-48293	28, 1979 p0628 A80-52860
Peat char gasification - Laboratory and PDU-scale	Silicon solar cell array technology and the
ctudice Process Davelonment Unit	
studies Process Development Unit	prospects for cost reduction
p0674 A80-48294 An advanced technology iron-nickel battery for	prospects for cost reduction p0628 A80-52861 Solar Power Generation Conference, San Jose,
p0674 A80-48294 An advanced technology iron-nickel battery for electric vehicle propulsion	p0628 A80-52861 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings
p0674 A80-48294 An advanced technology iron-nickel battery for electric vehicle propulsion p0766 A80-48327	p0628 A80-52861 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867
p0674 A80-48294 An advanced technology iron-nickel battery for electric vehicle propulsion p0766 A80-48327 Georgetown University's experience in the atmospheric fluidized bed combustor technology	p0628 A80-52861 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867 DOE solar thermal power systems program p0629 A80-52869
p0674 A80-48294  An advanced technology iron-nickel battery for electric vehicle propulsion p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332	p0628 A80-52861 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867 DOE solar thermal power systems program p0629 A80-52869 DOE view of solar power commercialization and
p0674 A80-48294  An advanced technology iron-nickel battery for electric vehicle propulsion p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington	p0628 A80-52861 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867 DOE solar thermal power systems program p0629 A80-52869 DOE view of solar power commercialization and applications p0629 A80-52870
p0674 A80-48294  An advanced technology iron-nickel battery for electric vehicle propulsion p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345	p0628 A80-52861 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867 DOE solar thermal power systems program p0629 A80-52869 DOE view of solar power commercialization and applications p0629 A80-52870 Relative merits of alternate linking techniques
P0674 A80-48294  An advanced technology iron-nickel battery for electric vehicle propulsion  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance	p0628 A80-52861 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867 DOE solar thermal power systems program p0629 A80-52869 DOE view of solar power commercialization and applications p0629 A80-52870 Relative merits of alternate linking techniques for underground coal gasification and their system design implications
P0674 A80-48294  An advanced technology iron-nickel battery for electric vehicle propulsion  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  P0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications  p0688 A80-52969  Research needs for coal gasification and coal
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361	p0628 A80-52861 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867 DOE solar thermal power systems program p0629 A80-52869 DOE view of solar power commercialization and applications p0629 A80-52870 Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969 Research needs for coal gasification and coal liquefaction p0688 A80-53274 The extraterrestrial imperative. III - New earth-space energy metabolism. I
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOB solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361	p0628 A80-52861 Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867 DOE solar thermal power systems program p0629 A80-52869 DOE view of solar power commercialization and applications p0629 A80-52870 Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969 Research needs for coal gasification and coal liquefaction p0688 A80-53274 The extraterrestrial imperative. III - New earth-space energy metabolism. I
An advanced technology iron-nickel battery for electric vehicle propulsion  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program  p0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program p0677 A80-48427  Assessment of current research and development in	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOB solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program  p0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program  p0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979 p0781 A80-53568
An advanced technology iron-nickel battery for electric vehicle propulsion  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  PO727 A80-48347  Power management for multi-100 KWe space systems p0728 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program p0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program p0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment P0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979 p0781 A80-53568  Tidal energy and the energy crisis - An assessment
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program p0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program p0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979 p0781 A80-53568
An advanced technology iron-nickel battery for electric vehicle propulsion  P0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance p0727 A80-48347  Power management for multi-100 KWe space systems p0728 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program p0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program p0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of B-Coal  LC-Fining of solvent refined coal - SRC-I and short contact time coal extracts Lummus	Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment P0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979 p0781 A80-53568  Tidal energy and the energy crisis - An assessment of technology and the interrelationship p0689 A80-53682  Environmental concerns for OTEC identified in the
An advanced technology iron-nickel battery for electric vehicle propulsion  P0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  P0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program  P0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program  P0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal  P0677 A80-48429  LC-Fining of solvent refined coal - SEC-I and short contact time coal extracts Lummus Cities Fining catalytic hydrogenation process	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOB solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment P0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979  Tidal energy and the energy crisis - An assessment of technology and the interrelationship p6689 A80-53682  Environmental concerns for OTEC identified in the
An advanced technology iron-nickel battery for electric vehicle propulsion  P0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance p0727 A80-48347  Power management for multi-100 KWe space systems p0728 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program p0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program p0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of B-Coal  LC-Fining of solvent refined coal - SRC-I and short contact time coal extracts Lummus	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53223  The potential role of biofuels within the built environment environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979 p0781 A80-53568  Tidal energy and the energy crisis - An assessment of technology and the interrelationship p0689 A80-53682  Environmental concerns for OTEC identified in the DOE OTEC Environmental Readiness Document p0576 A80-53687  Aspects of commercializing coal-derived methanol
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program p0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program p0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal  C-Pining of solvent refined coal - SRC-I and short contact time coal extracts Lummus cities Fining catalytic hydrogenation process p0678 A80-48431  Solar thermal electric power systems in Japan p0620 A80-48916	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOB solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979 p0781 A80-53568  Tidal energy and the energy crisis - An assessment of technology and the interrelationship p0689 A80-53682  Environmental concerns for OTEC identified in the DOE OTEC Environmental Readiness Document p0576 A80-53687  Aspects of commercializing coal-derived methanol fuels in the United States, 1985 to 2000.
An advanced technology iron-nickel battery for electric vehicle propulsion  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  PO727 A80-48347  Power management for multi-100 KWe space systems p0728 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program p0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program p0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of B-Coal  LC-Fining of solvent refined coal - SRC-I and short contact time coal extracts Lummus Cities Fining catalytic hydrogenation process p0678 A80-48431  Solar thermal electric power systems in Japan	p0628 A80-52861  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53223  The potential role of biofuels within the built environment environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979 p0781 A80-53568  Tidal energy and the energy crisis - An assessment of technology and the interrelationship p0689 A80-53682  Environmental concerns for OTEC identified in the DOE OTEC Environmental Readiness Document p0576 A80-53687  Aspects of commercializing coal-derived methanol
An advanced technology iron-nickel battery for electric vehicle propulsion  p0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  p0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0728 A80-48361  The Department of Energy's major project coal liquefaction program  p0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program  p0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal  p0677 A80-48429  LC-Fining of solvent refined coal - SRC-I and short contact time coal extracts Lummus cities Fining catalytic hydrogenation process p0678 A80-48431  Solar thermal electric power systems in Japan p0620 A80-48916  The economics of energy prices - Doubts and	solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOB solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979  Tidal energy and the energy crisis - An assessment of technology and the interrelationship p0689 A80-53682  Environmental concerns for OTEC identified in the DOE OTEC Environmental Readiness Document p0576 A80-53687  Aspects of commercializing coal-derived methanol fuels in the United States, 1985 to 2000. Volume 1: Market evaluation [FE-2416-44-VOL-1] p0690 N80-28542 Aspects of commercializing coal-derived methanol
An advanced technology iron-nickel battery for electric vehicle propulsion  P0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground coal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance P0727 A80-48347  Power management for multi-100 KWe space systems p0728 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program P0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program P0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal LC-Fining of solvent refined coal - SHC-I and short contact time coal extracts Lumnus Cities Fining catalytic hydrogenation process p0678 A80-48431  Solar thermal electric power systems in Japan p0620 A80-48916  The economics of energy prices - Doubts and uncertainty P0573 A80-49396  Recycling World Congress, 2nd, Manila,	Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOE solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52869  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979 p0781 A80-53568  Tidal energy and the energy crisis - An assessment of technology and the interrelationship p0689 A80-53682  Environmental concerns for OTEC identified in the DOE OTEC Environmental Readiness Document p0576 A80-53687  Aspects of commercializing coal-derived methanol fuels in the United States, 1985 to 2000.
An advanced technology iron-nickel battery for electric vehicle propulsion  P0766 A80-48327  Georgetown University's experience in the atmospheric fluidized bed combustor technology p0675 A80-48332  Characterization of a potential underground ccal gasification site in the State of Washington p0676 A80-48345  Review of mini-OTEC performance  P0727 A80-48347  Power management for multi-100 KWe space systems p0758 A80-48357  Advanced power technology for fusion reactors p0728 A80-48359  Direct energy conversion for fusion power p0729 A80-48361  The Department of Energy's major project coal liquefaction program  P0677 A80-48427  Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program  P0677 A80-48428  H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal  LC-Fining of solvent refined coal - SEC-I and short contact time coal extracts Lumnus Cities Fining catalytic hydrogenation process p0678 A80-48431  Solar thermal electric power systems in Japan p0620 A80-48916  The economics of energy prices - Doubts and uncertainty	solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  DOB solar thermal power systems program p0629 A80-52869  DOE view of solar power commercialization and applications p0629 A80-52870  Relative merits of alternate linking techniques for underground coal gasification and their system design implications p0688 A80-52969  Research needs for coal gasification and coal liquefaction p0688 A80-53274  The extraterrestrial imperative. III - New earth-space energy metabolism. I p0688 A80-53323  The potential role of biofuels within the built environment p0688 A80-53474  Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979  Tidal energy and the energy crisis - An assessment of technology and the interrelationship p0689 A80-53682  Environmental concerns for OTEC identified in the DOE OTEC Environmental Readiness Document p0576 A80-53687  Aspects of commercializing coal-derived methanol fuels in the United States, 1985 to 2000. Volume 1: Market evaluation [FE-2416-44-VOL-1] p0690 N80-28542 Aspects of commercializing coal-derived methanol

	,
Survey of world coal energy studies and	WASA authorization, 1981, volume 5
international coal mining research	[GPO-61-213-VOL-5] p0581 880-30225
[PB-2468-68] p0691 H80-28551	Report of the 6th Ocean Thermal Energy Conversion
Alternative fuels, fuel additives and related	Conference. Ocean Thermal Energy for the 1980's
devices for highway vehicles: R, D and D	[COMP-790631-1] p0701 M80-30922
proposal guidelines	Solar assisted heat pump program overview and
[DOB/CS-0154] p0693 #80-28571	summary of work at Brookhaven National Laboratory
Solar/hydrogen systems assessment. Volume 1:	[BHL-27662] p0642 M80-30926
Solar/hydrogen systems for the 1985 - 2000 time frame	MASA program plan [MASA-TH-81136] p0781 M80-31269
[NASA:-CB-163392] p0665 N80-28865	[BASA-TH-81136] p0781 B80-31269 Bultiphase reactor modeling for zinc chloride
Hagma energy: A feasible alternative	
[SAND-80-0309] p0693 H80-28874	catalyzed coal liquefaction [LPL-9870] p0703 H80-31628
Electric utility solar energy activities:	Liquid fuels from biomass: Catalysts and reaction
1979survey	conditions
[EPRI-EB-1299-SR] p0631 880-28879	[LBL-9789] p0705 B80-31646
Solar energy for buildings handbook	
[ORO-5362-T1] p0631 880-28880	Survey of biomass gasification. Volume 3:
	Current technology and research
Sun Valley photovoltaic power project, phase 1 [ALO-4281-1] p0633 H80-28909	[SERI/TR-33-239-VOL-3] p0705 H80-31648
	Instrumentation and process control development
International energy indicators [DOB/IA-00011/3(80)] p0781 H80-28919	for in situ coal gasification [SAND-80-1025] p0706 N80-31655
Potential for hydropower development at existing	Basic research needs and priorities in solar
dans in New England Volume 1: Physical and	energy. Volume 1: Executive summary.
economic findings and methodology	Technology crosscuts for DOB
[PB80-169121] p0578 #80-28934	[SERI/TR-351-358-VOL-1] p0645 H80-31898
	Possil energy program
Data Betwork monitoring performance of solar	[ORNL-5630] p0707 M80-31902
energy demonstration projects	Evaluation of line focus solar central power
[SOLAB/0010-79/12] p0633 H80-28947	systems. Volume 1: Executive summary
Vegetation as an indicator of high wind velocity	[ATE-80 (7773-03) - 1-VOL-1] p0648 #80-31943
[BLO-2227-T24-79/1] p0694 H80-28996	Evaluation of line focus solar central power
The outlook for nuclear power	systems. Volume 2: Systems evaluation
[PB80-175755] p0579 B80-29156	[ATR-80(7773-03)-1-VOL-2] p0648 N80-31944
Solaroil project. Phase 1: Preliminary design	Ocean energy systems: Multiyear program plan
report	[DCB/CS-0161] p0707 H80-31946
[GA-A-15823] p0633 N80-29505	Solar central receiver hybrid power systems
Bnvironmental data energy technology	sodium-cooled receiver concept. Volume 1:
characteristics: Synthetic fuels	Executive summary .
[DOE/EV-0073] p0579 #80-29516	[DOE/ET-20567/1-1] p0648 N80-31948
Peat as a fuel at the proposed Central Marine	Methodology for the comparative assessment of the
Power Company 600 MW plant, volume 1	Satellite Power System (SPS) and alternative
[PB80-175185] p0697 #80-29524	technologies
Market penetration of energy supply technologies	[NASA-CR-163049] p0750 N80-31951
p0579 N80-29837	Determination of air pollutant emission factors
Solar heating and hot water system installed at	for thermal tertiary oil recovery operations in
office building, One Solar Place, Dallas, Texas	California, volume 1
[ WASA-CR-161483] p0634 W80-29846	[PB80-187594] p0585 N80-31982
Solar heating and cooling system installed at	Determination of air pollutant emission factors
Leavenworth, Kansas	for thermal tertiary oil recovery operations in
[NASA-CR-161484] p0635 H80-29848	California. Volume 2: Appendix
Solar energy system economic evaluation: IBM	[PB80-187602] p0585 N80-31983
System 2, Togus, Maine	Pollutants from synthetic fuels production: Coal
[NASA-CR-161510] p0635 H80-29854	gasification screening test results
High temperature thermal energy storage in steel	[PB80-182769] p0707 N80-31986
and sand	Micro-level land use impacts of bioconversion
[NASA-CE-159708] p0776 E80-29860	[LA-UR-80-1426] , p0709 N80-32562
Rapporteur report: MHD electric power plants	Reference energy systems as applied to regional
[NASA-TH-81554] p0743 N80-29862	energy policy
Thin file polycrystalline silicon solar cells	[BNL-26987] p0587 #80-32883
[SAN-2207-T4] p0638 N80-29879	Line-focus solar thermal energy technology
The 20 percent solar energy goal: Is there a plan to attain it?	development. Report for Department 4720
[EMD-80-64] p0638 B80-29880	[SAND-80-0865-REV] p0651 N80-32887
User evaluation study of passive solar residences	US National Photovoltaics Program and applications
[SEBI/TP-63-350] : p0638 N80-29682	experiments in the intermediate sector
Preliminary comparative assessment of land use for	[SAND-80-0587C] p0654 880-32935
the Satellite Power System (SPS) and alternative	Potential displacement of petroleum imports by
electric energy technologies	solar energy technologies [SERI/TE-352-504] p0656 E80-32959
[NASA-CR-163327] p0580 N80-29886	
Selection of alternative central-station	Department of Housing and Orban Development solar hot water initiative: Centralized coordination
technologies for the Satellite Power System	of technical tasks and system evaluation
(SPS) Comparative assessment	[PB80-189244] p0656 N80-32961
[DOB/ER-0052] p0580 880-29887	Porecasts of energy technology. Citations from
National solar optical materials program plan: An	the International Aerospace Abstracts data base
overview	[ NASA-CE-163596 ] p0782 N80-32965
[SEBI/TP-641-619] p0639 N80-29892	Basic Research in Engineering: Process and
Overview-absorption/Rankine solar cooling program	Systems Dynamics and Control. High Priority
[LBL-10770] p0640 880-29904	Research Needs Relevant to Energy
Environmental data, energy technology	[PE-2468-65] p0590 N8Q-33167
characterizations: Geothermal	Synchronous energy technology program
[DOB/EV-0077] p0580 M80-29912	p0657 #80-33466
Energy/Environment 4: Proceedings of the National	Hydrogen use as a fuel. Citations from the NTIS
Conference on the Interagency Energy/Environment	data base
B and D. Program	
	[PB80-813090] p0667 B80-33607
[PB80-177942] p0581 H80-29928	Solar heating system at Cuitman County Bank,
[PB60-177942] p0581 H80-29928 DOE authorization, 1981, volume 2 [GP0-61-774-VOL-2] p0581 H80-30224	

SUBJECT INDEX ENVIRONMENT REPECTS

Design and development of Stirling engines for stationary power applications in the 500 to 3000 hp range. Subtask 1A report: State-of-the-art State-of-the-art reviews and bibliographies on energy. Citations from the NTIS data base [PB80-812886] p0782 N80-33917 State-of-the-art reviews and bibliographies on conceptual design Citations from the NTIS data base [ DOB/BT-15209/T1] p0744 N80-30755 Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] p0583 N80p0583 N80-31274 Improved components for engine fuel savings
[NASA-TH-81577] p0583 B80-31402
The energy efficient engine project
[NASA-TH-81566] p0585 N80-32395 The use of solar energy for cooking p0659 N80-33953 p0585 880-32395 Technology Assessment. Citations from the NTIS Upgraded automotive gas turbine engine design and development program, volume 2
[NASA-CR-159671] p0751 N80-32 data base [PB80-813165] p0783 N80-34299 p0751 N80-32719 Technology Assessment. Citations from the NTIS Design and development of Stirling engines for stationary power generation applications in the 500 to 3000 horsepower range data base [PB80-813173] p0783 N80-34300 [DOB/ET-15207/T1] p0752 M80-Potential of diesel engine, 1979 summary source BUBRGY TRANSPER p0752 #80-32723 Status of nuclear high temperature process heat development in the Federal Republic of Germany document [FB80-193659] p0585 M80-Potential of diesel engine, emission technology [FB80-192685] p0586 M80-/coal gasification and long distance energy p0585 N80-32734 p0758 180-48311 The pressurized fluidized bed gasification of coal p0586 N80-32735 ENGINE PARTS char Improved components for engine fuel savings p0583 N80-31402 [BLL-RTS-12347] p0712 N80-33575 [NASA-TM-81577] BEGINE TESTS ENGINE DESIGN JT9D-7A /SP/ jet engine performance deterioration On calculating gas turbine efficiency reduction under the influence of air cooling trends p0569 A80-44230 P0721 A80-47415 Photocell heat engine solar power systems Power production from geothermal brine with the p0612 A80-48179 rotary separator turbine Analysis and design of free-piston Stirling p0725 A80-48266 engines - Thermodynamics and dynamics The MOD-2 wind turbine p0729 A80-48407 Harmonic analysis of Stirling engine thermodynamics p0727 A80-48322 Design characteristics and test results of the P0730 A80-48408 United Stirling P40 engine Performance loss due to transient heat transfer in the cylinders of Stirling engines p0731 180-48452 Validation of published Stirling engine design methods using engine characteristics from the D0730 A80-48410 -An algorithm for the preliminary design of literature p0734 A60-48497 Investigation of a Philips MP 1002 CA Stirling Stirling engine heaters D0730 A80-48411 Design considerations for a near-term hybrid vehicle enginé p0734 A80-48499 p0571 A80-48420 Development of a diaphragm Stirling engine heat-actuated heat pump RNGINEBRING TRST REACTORS MHD power plants and from recent ETF design work
--- Engineering Test Pacility p0731 A80-48425 Design characteristics and test results of the United Stirling P40 engine The Engineering Test Facility - The next major development in the U.S.A. fusion program p0733 A80-48491 p0717 A80-44107 p0731 A80-48452 Stirling engine power system development and test results p0731 A80-48453 BRTRAINNENT Coal processing for fuel cell utilization: Task 9: One-dimensional (streamtube) model for Stirling engines for developing countries 9: One-dimensional (streamtube) model for entrained-flow gasifier analysis [METC-8450-T2-VOL-1] p0707 B6 p0732 A80-48454 Applications of free-piston Stirling engines p0732 180-48456 p0707 N80-31912 An advanced 15 kW solar powered free-piston BUTROPY Stirling engine Second law analysis of energy devices and processes: Proceedings of the Workshop, George Washington University, Washington, D.C., August p0619 A80-48467 Validation of published Stirling engine design methods using engine characteristics from the D0576 A80-51202 D0734 A80-48497 Second law and radiation A state space analysis of a symmetrical compounded free piston Stirling engine p0738 A80-51203 BUVIRONMENT REFECTS P0734 A80-48498 An environmental assessment of the satellite power Investigation of a Philips MP 1002 CA Stirling system reference design p0757 A80-46396 engine Solar power satellites - The ionospheric connection p0757 180-46397 Nodal analysis of miniature cryogenic coolers p0734 A80-48500
An analytical solution for a Stirling machine with
an adiabatic cylinder Environmental effects of space systems - A review p0757 A80-46880 an adiabatic cylinder Radiation effects on solar cells p0734 A80-48501 p0609 180-46894 Regenerative engines with dense phase working fluids - The Malone cycle An attempt at balancing the environmental effects of electric power generation with the framework of the country's economic system p0734 A80-48502 Trade-off results and preliminary designs of Hear-Term Hybrid Vehicles [SAB PAPER 800064] p0772 A p0575 A80-50820 Energy choices and environmental constraints p0772 A80-49723 p0576 A80-51933 Gas turbines for automotive use --- Book push-pull test - A method of evaluating p0736 A80-50351 formation adsorption parameters for predicting the environmental effects on in-situ coal The solution to the gas turbine temperature problem - engine design gasification and uranium recovery

p0738 A80-50949

D0576 A80-52968

Bryironmental concerns for OTEC identified in the DOE OTEC Environmental Readiness Document	Costing methodologies for energy systems [BHL-27603] p0778 H80-3290 ENVIRONMENT PROTECTION
p0576 A80-53687 1979 status of the OTEC Environment Program p0577 A80-53689	Environmental protection - Cooperation versus enactments
The renaissance of coal prospects and problems of increased worldwide utilization	p0569 A80-4384. Solar power satellites - The present and the future
p0689 A80-54036	p0757 A80-4756
The long-term effects of trace elements emitted by energy conversion of lignite coal. Volume 2: Technical appendices	Energy conservation and environmental benefits of thermal energy storage systems in the pulp and paper industry
[PB80-168875] p0579 #80-28960	p0763 A80-4819
The direct use of coal. Volume 2, part B:	Economic performance model of APBC systems
Working papers, appendices 7-9	Atmospheric Pluidized Bed Combustion
[PB80-184526] p0697 B80-29521	p0571 A80-4819
The direct use of coal. Volume 2, part C: Working papers, appendices 10-14 [PB80-184534] p0697 M80-29522	Energy expenditure for environmental protection - A contribution to efficiency analysis p0575 A80-5081
Steam engine analysis	The significance of the gas economy from the
[PE-8917-2] . p0743 N80-29741	viewpoint of environmental protection
Some questions and answers about the Satellite	p0575 A80-5082
Power System (SPS) [NSA-CP-1633201 -00630 NOC-20907	Ensured power supply and environmental protection
[NASA-CR-163329] p0639 N80-29897 Solar energy system economic evaluation final	as elements of a provident social policy p0575 A80-5082
report for SENCO-Loxabatchee, Loxabatchee	Environmental concerns for OTEC identified in the
National Wildlife refuge, Palm Beach County,	DOE OTEC Environmental Readiness Document
Florida	p0576 A80-5368
[NASA-CR-161512] p0641 N80-30894	Trace element characterization of coal wastes
Climate and energy: A comparative assessment of	[PB80-166150] p0577 N80-2848
the Satellite Power System (SPS) and alternative	Environmental data energy technology
energy technologies [DOE/EE-0050] p0581 N80-30914	characteristics: Synthetic fuels [DOE/EV-0073] p0579 N80-2951
Comparative assessment of environmental welfare	Environmental constraints on geothernal energy
issues associated with the Satellite Power	[ORNL-1310] p0580 N80-2986
System (SPS) and alternative technologies	Environmental data, energy technology
[DOB/ER-C055] p0581 #80-30915	characterizations: Geothermal
Energy analysis program, FY 1979	[DOB/EV-0077] p0580 N80-2991
[LBL-10320] p0582 B80-30942 South Atlantic OCS physical oceanography, volume 2	Energy/Environment 4: Proceedings of the National Conference on the Interagency Energy/Environment
monitoring ocean currents and sea states to	R and D Program
assess effects of oil and gas activities on the	[FB80-177942] p0581 N80-29920
environment	Proceedings of the Clemson Workshop on
[PB80-181555] p0582 N80-31026	Environmental Impacts of Pumped Storage
South Atlantic OCS physical oceanography, volume 3	Hydroelectric Operations
monitoring ocean currents and sea states to assess the environment effects of oil and gas	[PB80-192453] p0588 H80-3296 Effects of gasohol on idle HC and CO emissions
activities	[PB80-190655] p0590 N80-3301
[PB80-181563] p0583 N80-31027	International Conference on Air Pollution, volume 1
Possil fuels research matrix program. US	[ISBN-0-7988-16651] p0592 N80-3392
Environmental Protection Agency/Department of	Environment: The energy connection
Energy Possil Fuels Research Materials Facility	p0592 N80-3395
[ORNL/TH-7346] p0583 N80-31632 The fate and effects of crude oil spilled on	Environmental air quality control from the inside looking out
subarctic permafrost terrain in interior Alaska	p0592 N80-3396
[PB80-187305] p0585 N80-31984	BEVIROBMENTAL CONTROL
A methodology for the environmental assessment of	Environmental control technology for atmospheric
advanced coal extraction systems	carbon dioxide
[NASA-CR-163570] p0586 N80-32827 Proceedings of the Clemson Workshop on	p0569 A80-4530 Assessment of environmental control technologies
. Environmental Impacts of Pumped Storage	for energy storage systems, 1979
Hydroelectric Operations	[LA-8308-MS] p0588 M80-3297
.[PB80-192453] p0588 N80-32964	Environmental-control-technology activities of the
Environmental assessment report: Wellman-Galusha	Department of Energy in FY 1979
low-Btu gasification systems	[DOE/EV-0084] p0589 M80-3298
[PB80-190796] p0589 M80-32995 Cleaning agents and techniques for concentrating	ENVIRONMENTAL LABORATORIES  Efficient thermal cycling of solar panels in solar
solar collectors	simulation facilities with a multi-panel test rig
[SAND-79-7052] p0659 N80-33911	p0659 N80-3389
Preliminary study of the potential environmental	BEVIROBHESTAL SOMITORING
concerns associated with surface waters and	A new era in technology; Proceedings of the
geothermal development of the Valles Caldera [LA-8398-MS] p0592 M80-33969	Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980
ENVIRONMENT HANAGEMENT	p0781 A80-51920
General application of the critical path method to	Sorption properties of sediments and
resource characterization and planning for	energy-related pollutants
underground coal mining	[PB80-189574] p0589 N80-3299
[DOE/ET-11268/3] p0707 880-32272	ENVIRONMENTAL TESTS
Environmental implications of electric utility	Testing flat plate photovoltaic modules for terrestrial environment
supply plans, 1978-2000 [PB80-192156] p0588 H80-32963	p0608 A80-4678
ENVIRONMENT POLLUTION	Rocky Flats Small Wind Systems Test Center
Environmental protection - Cooperation versus	activities. Volume 1: Atmospheric test data
enactments	collected from Small Wind Energy Conversion
p0569 A80-43843	Systems
Environmental impact of conversion of refuse to	[RFP-3004-VOL-1] p0746 B80-3090 Collector sealants and breathing
energy p0574 A80-49954	[DOE/CS-15362/1] p0650 H80-3252
Energy choices and environmental constraints	[
p0576 A80-51933	
	•

SUBJECT TEDEX PABRICATION

Qualification test results of the production high efficiency K6-3/4 and K7 silicon solar cells p0658 N80-33886 BIBAUST BRISSION Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost BPITARY CdTe homojunctions solar cells D0573 A80-49648 p0603 180-46731 High-efficiency AlGals/Gals concentrator solar Sulfate in diesel exhaust p0575 A80-50528 cells by organometallic vapor phase epitary Optimization problems of emission reduction in large fossil-fuel combustion facilities p0610 A80-46952 Some electric and photoelectric properties of photodetectors based on epitaxial layers Si/x/Ge/1-x/ with diffused p-n junction p0576 A80-51500 Advanced combustion systems for stationary gas turbine engines. Volume 4: Combustor verification testing, addendum p0610 A80-47153 **EPOIT NATRIE COMPOSITE MATERIALS** [Pb80-179849] p0698 880-30313 Low cost composite materials for wind energy Environmental control technology for carbon dioxide p0588 N80-32972 conversion systems [ DOB/BV-0079 ] Methanol/ethanol/gasoline blend fuels demonstration with stratified charge engine D0717 A80-44104 EQUATIONS OF HOTION A simulation model for wind turbines vehicles P0738 A80-50972 ſ PB80-1921231 D0713 N80-33606 BEHABST GASES RTHARR Effluent-free flue gas scrubbing process to separate the fine dust and the noxious gases Economic evaluation of the MIT process for manufacture of ethanol [DSE-3992-T1] p0705 N80-31647 from waste combustion plants ETHYL ALCOHOL p0574 A80-49968 Adapting geothermal energy to produce ethanol for automotive fuel Application of the lime/limestone flue gas desulfurization process to smelter gases p0723 180-48183 p0576 A80-53084 Advanced combustion systems for stationary gas turbine engines. Volume 2: Bench scale Permentation ethanol as a petroleum substitute p0675 A80-48324 Alcohol fuels for spaceship earth evaluation [FB80-175607] p0744 %80-29922 Evaluation of the Ram-Jet device, a PCV air bleed p0686 A80-51953 The Brazilian National Alcohol Programme p0687 A80-52855 [ FB80-170657 ] p0582 N80-30964 Hydrothermal energy: A source of energy for alcohol production [CONF-800526-1] p0698 B Photochemical study of NOx removal from stack gases
[PB80-181274] p0582 N80-30966 EXOTERRAC BEACTIONS p0698 880-29869 Safety studies on Li/SO2 cells. IV -Investigations of alternate organic electrolytes EUROPE . Capital requirements for the development in the field of energy in the Eastern European countries on the eve of the nineties for improved safety p0737 A80-50507 p0572 A80-49394 The investment needs of the coal industry of the Lead-acid battery expander. I - Electrochemical **European Community** evaluation techniques p0573 A80-49399 p0761 A80-47137 Solar energy applications for dwelling; modelling and simulation part

[EUR-6681/I-EN] p0645 N80-318 Experimental design for Hydraulic Transport p0645 N80-31894 Research Facility [PE-3274-1] EUROPEAN SPACE PROGRAMS p0759 N80-29629 Satellite power systems for Western Europe -Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80 Problems and solution proposals p0622 A80-50633 p0753 N80-32950 European technology applicable to Solar Power BEPERIMENTATION Study on the utilization of solar energy for the operation of Spacelab material science furnaces [ESI-CE(P)-1301] p0640 M80-30 Satellite Systems (SPS)
[INKA-CONF-79-378-046] n0637 N80-29878 p0640 N80-30348 **EVALUATION** Solar energy system performance evaluation. EXPLOSIVE DEVICES Seasonal report for SEECO Lincoln, Lincoln, Magnetoplasma compressor with an explosion-driven Nebraska magnetic power generator p0635 N80-29851 p0717 A80-44185 [ BASA-CR-161495] Hydrogen engine performance analysis project [SAN-1212-T1] p0665 #80-30756 Effect of a heated atmosphere on the emittance of quantitative evaluation of closed-cycle ocean black chrome solar collector pipe surfaces
[UCRL-83506] p0631 N
EXTRATBREESTRIAL BESOURCES thermal energy conversion (OTEC) technology in central station applications p0631 N80-28877 p0749 880-31885 [R-2595-DOB] The extraterrestrial imperative. III - New Pederal demonstrations of solar heating and cooling on commercial buildings have not been earth-space energy metabolism. I p0688 A80-53323 very effective EXTREME ULTRAVIOLET RADIATION [EHD-80-41] P0750 N80-31929
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80(7773-03)-1-V0L-2] P0648 N80-31944 Use of generalized population ratios to obtain Fe XV line intensities and linewidths at high electron densities Continued evaluation of compact heat exchangers for OTEC evaluation RETRRMUM VALUES Eigenvalue bounds for Hill's equation --- in [COO-4238-14] stability theory for magnetohydrodynamic p0750 N80-31945 Reference energy systems as applied to regional equilibria energy policy
[BNL-26987] p0587 880Evaluation of cranking characteristics of
conmercially available batteries between room p0720 A80-45651 p0587 180-32883 temperature and -40 C PARRICATION Production of photovoltaic devices
[ASMB PAPER 79-SOL-8] FAD-A0806141 . p0780 N80-33906 EXHAUST DIFFUSERS p0596 A80-45662 Potential for improved silicon ribbon growth Tests of a lightweight 200 kW MHD channel and diffacer through thermal environment control [AD-A087022] p0601 A80-46704 p0751 N80-32226

Ion implanted solar cells from BFG silicon ribbons Bpitaxial Film Growth	Canadian biomass perspective - A new interest in an old fuel
p0601 A80-46705	.p0687 A80-52856
Low cost processes for silicon fabricated for solar cells	Investigation of the feasibility of methanol as an automobile fuel
p0606 A80-46757	p0688 A80-52881
Advances in theory, fabrication and applications of bifacial solar cells	Technical and economic feasibility of alternative fuel use in process heaters and small boilers
p0606 A80-46769	[DOE/EIA-10547/01] p0693 N80-28570
Alternate fabrication process for molten carbonate fuel Cell electrolyte structures	Thermal energy storage systems using fluidized bed heat exchangers
p0721 180-47136	[ NASA-CR-159868] p0775 N80-28866
Induced junction solar cell and method of fabrication	Peat as a fuel at the proposed Central Marine Power Company 600 MW plant, volume 1
[NASA-CASE-MPO-13786-1] p0634.M80-29835	[PB80-175185] . p0697 N80-29524
Reactively sputtered thin film cu/sub x/S/CdS photovoltaic devices	Peasibility study for industrial cogeneration fuel cell application
[UCID-18592] p0637 N80-29875	[SAN-1889-T1] p0746 N80-30934
Advanced rhotovoltaic concentrator cells [DSE-4042-T30] p0643 H80-30946	Peasibility study: Fuel cell cogeneration in a water pollution control facility, volume 1
Pilot line report: Development of a high	[DOE/ET-12431/T1-VOL-1] p0749 H80-31922
efficiency thin silicon solar cell [NASA-CR-163522] p0644 N80-31876	Costing methodologies for energy systems [BNL-27603] p0778 M80-32900
Advanced photovoltaic concentrator cells	US National Photovoltaics Program and applications
[DSE-4042-T40] p0645 H80-31904 Design and fabrication of combined	experiments in the intermediate sector [SAND-80-0587C] p0654 N80-32935
photovoltaic-thermal collectors	PEDERAL BUDGETS
[SAND-79-7008] p0652 N80-32890 Deposition, fabrication and analysis of	DOE authorization, 1981, volume 2 [GPO-61-774-VOL-2] p0581 N80-30224
polycrystalline silicon MIS solar cells	NASA authorization, 1981, volume 5
[DOE/PT-23044/4] p0653 N80-32920 Investigation of the impurity tolerance of	[GPO-61-213-VOL-5] p0581 N80-30225 National Aeronautics and Space Administration
semicrystalline silicon solar cells silicon	Authorization Act, 1981
inpact program [DOB/CH-00178/T2] p0654 N80-32934	[PUB-LAW-96-316] p0581 B80-30226 Environmental-control-technology activities of the
The 3X Compound Parabolic Concentrating (CPC)	Department of Energy in FY 1979
solar energy collector [DOE/CS-04239/T1] p0655 N80-32944	[DOE/EV-0084] p0589 E80-32989 FRED SYSTEMS
AILORE	Advanced coal gasification system for electric
Assessment of Synthane mechanical equipment [MTI-79TR5] p0710 N80-32572	power generation [FE-1514-97] p0700 N80-30548
AILURE ABALYSIS Altos-model 8B wind turbine generator. Failure	PREDEACK COSTROL
analysis	Describing-function method for estimating the performance of a dynamic system having
[RFP-3035/3533/79-10] p0742 N80-28925 Development of advanced batteries at Argonne	nonlinear-power take-off, with application to wave-power conversion
National Laboratory	p0739 A80-51464
[ANI-80-32] p0776 M80-30927 High energy density composite flywheel program	PREMERTATION  Fermentation ethanol as a petroleum substitute
[AD-A087076] p0777 N80-31892	p0675 A80-48324
AILORE MODES  Cycles till failure of silver-zinc cells with	Recovery of ethanol from fermentation broths using selective sorption-desorption
competing failure modes - Preliminary data analysis	p0678 A80-48516
p0761 A80-46414	Development of a methane fermentation process for organic wastes
Safety of wind energy conversion systems (WECS): Preliminary study risk to personnel and to	p0679 A80-49545 Biomass energy production. Citations from the
the surrounding area due to mechanical failure	International Aerospace Abstracts data base
[FFA-NU-2126] p0742 880-28933 AR IMPRARED RADIATION	[PB80-810807] p0711 N80-32578 PRBBOBLECTRICITY
Observations of fluctuating omega sub p emission	Demonstration of heat to electrical energy
in Alcator tokamaks p0736 A80-49075	conversion with a ferroelectric material p0729 A80-48386
ARM CROPS	PERROUS METALS
The potential of energy farming in the southeastern California desert	A method to reclaim metallic material and energy from automobiles
[PB80~195019] p0714 N80-33921	PIBER COMPOSITES P0684 A80-50024
Automatic-control system for the 17-metre Vertical	Rotating strength of laminated composite discs
Axis Wind Turbine (VANT) [SAND-78-0984] p0750 N80-31958	P0762 A80-47454
RASIBILITY ANALYSIS	Research and development for inertial energy
The feasibility of pellet re-fuelling of a fusion reactor	storage based on a flexible flywheel [SAND-79-7097] p0778 H80-32898
p0719 A80-44661	PIELD COILS
Feasibility of a peat biogasification process p0669 A80-46197	Tokamak poloidal field systems [LA-8375-PR] p0754 H80-33233
Hawaii Geothermal Project 'A' wellhead generator	PIELD EPPECT TRANSISTORS
feasibility project p0727 180-48316	Satellite Power Systems (SPS) concept definition study. Volume 6: In-depth element investigation
Peasibility studies of spoiler and aileron control	[NASA-CE-3323] p0651 M80-32859
systems for large horizontal-axis wind turbines p0727 A80-48318	Low cost composite materials for wind energy
Salton Sea solar pond project p0617 A80-48362	conversion systems p0717 180-44104
The economic feasibility of passive solar space	PILM THICKERSS
heating systems p0627 180-52832	On the influence of an interfacial oxide layer on Au/n-Gals Schottky barrier solar cells
· · · · · · · · · · · · · · · · · · ·	p0608 A80-46784

•	
Pluance Pinancing of renewable energy sources /solar, wind	Analytical prediction of the performance of an air photovoltaic/thermal flat plate collector
and biomass energy sources/ p0572 180-49392	[DOE/ET-20279/93] p0653 N80-32914 PLIGHT CONDITIONS
Capital requirements for energy in the industrialised countries	Energy conservation in terminal airspace through fuel consumption modeling
p0572 A80-49393 Capital requirements for the development in the	[SAE PAPER 800745] p0573 A80-49695 FLIGHT TESTS
field of energy in the Bastern Buropean countries on the eve of the nineties	RCA Satcom P1 and P2 Ni-Cd battery orbital performance
p0572 180-49394 Financing of energy investments - Capital and	PLORIDA PLORIDA
policy requirements of developing countries p0573 A80-49395	TIDP - Basic research for answering Florida's residential energy conservation questions
PINANCIAL MANAGEMENT  The challenge of financing geothermal development	p0576 A80-51954 FLOW CHARACTERISTICS
p0727 A60-48317 Assessment of risks in the financing of major	Study of gelled LNG characterization of gelled LNG with respect to process, flow, use
energy projects p0573 180-49397 Trends in financing LNG projects	properties, and safety [DOB/EV-02057/T2] p0695 N80-29506 PLOW DISTRIBUTION
p0573 180-49398	Thermographic techniques applied to solar
Financing for energy resources development projects - Japanese experience	collector systems analysis [SERI/TP-351-540] p0655 N80-32946
p0573 A80-49400	
FINITE DIFFERENCE THEORY  Numerical simulation of dual-media thermal energy	power for space heating in colder climates [DOE/DP-03533/T3] p0753 N80-32950
storage systems [ASHE PAPER 79-HI-35] p0761 A80-45725	Changes in the potential for wind energy generation due to terrain modification of the
Thermal stress in a composite cylinder by finite difference technique solar concentrator	boundary-layer flow p0714 N80-34020
tubular heat exchanger	PLOW REGULATORS
[ASME PAPER 80-HT-107] p0612 A80-48036	Performance and applications potential of a turbine-pump with controlled flow rate for
Comparison with strain gage data of centrifugal	solar and windpower energy storage
stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine	p0768 A80-48375
[SAND-79-1990] p0741 N80-28756	Maximum windmill efficiency
PLAME PROPAGATION Theory of reverse combustion along fissures in	p0737 A80-50721
fuel which gasifies at depth	Calculation of heat-transport-medium flow rate in
p0675 A80-48341 Development of combustion data to utilize low-Btu	heat receivers of passive solar-heating systems p0611 A80-47159
gases as industrial process fuels: Modification of flame characteristics	Pressure loss in a spiral solar energy collector p0624 A80-50971
[DOE/ET-14851/2] p0706 N80-31659	Autoignition characteristics of aircraft-type fuels
Vapor cloud explosion studies in the United States p0590 N80-33595	[NASA-CR-159886] p0698 N80-30535
PLANE TEMPERATURE	Effluent-free flue gas scrubbing process to
Progress in the development of small flame heated thermionic energy converters p0732 A80-48472	separate the fine dust and the noxious gases from waste combustion plants p0574 A80-49968
PLANNABLE GASES	Flue gas recirculation as a means of improving the
Hethane recovery from urban refuse p0670 180-47587	solid waste incineration process p0688 A80-53057
PLAPPING HINGES	Stack gas reheat evaluation
Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a	[PB80-196850] p0593 N80-33980 PLUID DINANICS
rigid rotor blade with the leading-edge angle of	One-dimensional model for pulverized coal
attack and flapping being coupled [ISD-244] p0747 N80-30949	combustion and gasification p0669 A80-45322
Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and	FLUID PLOW  Maximum windmill efficiency
variable-controlled blade pitch angle	p0737_A80-50721
[ISD-258] p0747 N80-30950	Fluid temperature control for parabolic trough solar collectors
Testing flat plate photovoltaic modules for	[SAND-79-2006C] p0652 N80-32894
terrestrial environment p0608 A80-46788	PLUID TRANSMISSION LINES  Benefits arising from the use of pneumatic energy
A two-dimensional analysis of flat plate air-heating solar collectors	transmittal in wind-power systems p0757 A80-48271
[ASME PAPER 80-HT-117] p0612 A80-48C38	PLUIDIZED BED PROCESSORS
A comparison of the flat plate and concentrating solar collector p0619 A80-48507	Coal gasification in fluidized bed combustion: Status and developments - Puture perspectives p0669 A80-45267
The effect of direct and diffuse radiations on the thermal performance of flat-plate solar collectors p0620 A80-48793	A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168
The optimal interconnection of solar collectors in air heating systems with large collector surfaces p0620 A80-48794	Selecting fines recycle methods to optimize fluid bed combustor performance p0671 A80-48169
Hybrid thermal-photovoltaic systems p0628 180-52865	methods of improving limestone utilization in
Analytical prediction of liquid photovoltaic/thermal flat-plate collector	p0672 A80-48170 An ergineering study on the use of regenerative
performance [COO-4094-66] p0646 N80-31913	calcium silicates sorbent for APB power generation from high sulfur coal Atmospheric
·	Fluidized Bed p0672 180-48171

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Hydration of 'spent' limestone and dolomite to enhance sulfation in fluidized-bed combustion	Eotating strength of laminated composite discs p0762 A80-4745
P0672 A80-48172 Economic performance model of AFEC systems	The new age of high performance kinetic energy storage systems p0768 A80-4837
Atmospheric Pluidized Bed Combustion p0571 A80-48199 Economic analysis of coal burning fluidized bed	Residential photovoltaic flywheel storage system performance and cost
steam and by-product power generation systems for industrial facilities p0672 A80-48200	p0768 A80-4837 Plywheel-transmission characteristics required for break-even impact on automotive vehicle
Circulating fluidized bed boiler p0672 180-48201	performance p0768 A80-4837
Design and operation of fluidised bed industrial boilers and hot gas producers	Energy conservation with flywheels p0773 A80-5091
p0672 A80-48202 Study of thermal energy storage using fluidized bed heat exchangers	Regenerative flywheel energy storage system [UCRL-13982-RRV-1] The SNIAS magnetic bearing wheel
p0764 180-48240  Past fluid bed coal gasification in a process development unit	[SMIAS-792-421-101] p0775 N60-2892 Passive radially centered magnetic suspension for high velocity rotors
p0672 A80-48245 Historical development of the U-GAS process at the	[SNIAS-792-422-109] p0775 N80-2893 System design, tests results, and economic
IGT pilot plant p0673 A80-48246 Helium-topping/organic bottoming - Advanced power	analysis of a flywheel energy storage and conversion system for photovoltaic applications [COO-4094-70] p0746 M80-3092
generation system Exergetic/energetic analysis p0673 A80-48247	Plywheel energy management systems for improving the fuel economy of motor vehicles
The HYGAS process to produce pipeline gas from coal p0674 A80-48291	[PB80-175300] p0777 N80-3127 High energy density composite flywheel program
Georgetown University's experience in the atmospheric fluidized bed combustor technology p6675 180-48332	[AD-A087076] p0777 N60-3189 Design study of steel V-Belt CVT for electric vehicles
Coal-fired fluid bed combustion augmented compressed air energy storage systems	[NASA-CE-159845] p0777 R80-3229 Residential photovoltaic flywheel storage system
p0768 A80-48376 Pluidized bed combustion of refuse derived fuels p0684 A80-50019	performance and cost [DOB/ET-20279/92] p0587 N80-3287 Low-cost flywheel demonstration program
Puel gas from used tyres by means of the Babcock-Rohrbach process	[DOE/ET-26931/T1] p0778 H80-3289 Research and development for inertial energy
p0685 A80-50036 Thermal energy storage systems using fluidized bed	storage based on a flexible flywheel [SAND-79-7097] p0778 N80-3289
heat exchangers [BASA-CR-159868] p0775 B80-28866 Research and evaluation of biomass	Low-cost flywheel demonstration program [COMS-5085-T2] p0780 M80-3390 POANING
resources/conversion/utilization systems (market/experimental analysis for development of	Design of land-based, foam OTEC plants for bottoming cycles
a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 B80-30552	[COMF-790631-17] p0742 880-2891
Coal processing for fuel cell utilization. Task 11: Pluidized bed coal gasification model; data analysis and predictions	Grad B focusing and deposition of relativistic electron beams p0717 A80-4397
[METC-8450-T1] p0701 M80-30909 Processes to increase utilization of power solid	Effect of circumsolar radiation on performance of focusing collectors
wastes [ISM-245] p07C2 M80-30929 Coal gasification pilot plant support studies	[SERI/TR-34-093] p0646 H80-3191 Evaluation of line focus solar central power systems. Volume 1: Executive summary
[FE-2806-5] p0704 M80-31637 Coal gasification/gas cleanup test facility:	[ATR-80(7773-03)-1-VOL-1] p0648 880-3194 POLDIEG STRUCTURES
Volume 1. Description and operation p0707 N80-31990 [PB60-188378] Advanced coal gasification system for electric	SPOT solar array for a three axis stabilized heliosynchronous satellite in an 800 km orbit p0658 N80-3388
power generation [PB-1514-113] p0709 #80-32557	FOOD The use of solar energy for cooking
Miniplant and bench studies of pressurized fluidized-bed coal combustion [PB80-188121] p0712 M80-32999	p0659 H80-3395  FORECASTIEG  Comparative assessment of five long-run energy
The pressurized fluidized bed gasification of coal char	projections [DOE/EIA/CE-0016/02] p0582 M80-3093
[BLL-RTS-12347] p0712 H80-33575 The fluidized bed gasification of coal char [BLL-RTS-12346] p0712 H80-33576	Assumptions and ground rules used in nuclear waste projections and source term data [ONHI-24] p0585 B80-3220
Single particle gas-solid reactions and their application to modeling of fluidized bed coal combustors and ash agglomerating gasifiers	Documentation of volume 3 of the 1978 Energy Information Administration annual report to congress
PLUORESCENCE p0713 #80-33578	[DOE/EIA/CR-0456] p0782 N80-3286 PORRIGH TRADE
Fluorescent planar concentrators - Performance and experimental results solar collector absorbing diffuse and direct radiation via	Energy policy: Supply and demand alternatives [GPO-56-541] p0591 B80-3367 FORMALDERIDE
fluorescent molecules p0604 A80-46741	Photoreduction of carbon dioxide and water into formaldehyde and methanol on semiconductor
PLUCATIONS  Electrowinning of silicon from K2SiP6-molten fluoride systems	<pre>materials     p0621 A80-4892 An improved synthesis of 2,4,8,10-tetroxaspiro</pre>
p0622 180-50510	(5.5) undecane [BASA-CASE-ARC-11243-2] p0583 B80-3147
Selection of the optimal design parameters of an aircraft flywheel-type power supply system p0761 A80-47391	
F 200 11001	

DRHIC ACID  Puel cell applied research: Blectro	catalysis and	Alternate fabrication process for molte fuel cell electrolyte structures	n carbonate
materials [BNL-51053]	p0742 880-28920	p0 Testing of sintered Lill02 structures i	)721 A80-4713( .b molten
DRHULAS (HATHEMATICS)		carbonate fuel cells	
New method to determine the independ			1721 A80-4714
<pre>goduli of transversely isotropic u [CONP-800575-1]</pre>	p0712 N80-32796	Development of molten carbonate fuel ce power generation	115 101
OSSIL PURLS	F		726 180-4827
The CO2 problem from the viewpoint of	of geoecology	Industrial energy conservation with the	
and energy economy	-AEJE 100 EAR22	gas-fueled molten carbonate fuel cell	
Optimization problems of emission re	p0575 A80-50822	Development of a high temperature solid	571 A80-4828
large fossil-fuel combustion facil		electrolyte fuel cell	
	p0576 A80-51500		726 480-4828
Canadian biomass perspective - A new	/ interest in	Improvement in stacking structures of f	uel cells
an old fuel	8		726 A80-4828
The management of sonly and progressed	p0687 A80-52856	The kinetics of the 02/C02 reaction in	
The renaissance of coal prospect of increased worldwide utilization		carbonate - Reaction orders for O2 an in fuel cells	.d CO2 OH #10
or increased fortificate regardance.	p0689 A80-54036		726 180-4828
Coordinating fossil fuel research in	natural gas	Fuel cell systems for vehicular applica	
recovery			736 A80-4972
[PB80-169469]	p0697 N80-29527	Fuel cell applied research: Electrocat	alysis and
Intergenerational equity and conserve [NASA-CB-163434]	vation p0580 N80-29861	materials [BNL-51053] p0	742 N80-2892
Hagnetohydrodynamic generators in po		Fuel cell applied research: Electrocat	
generation. Citations from the N		materials	,
[ PB 80-8 10856 ]	p0748 N80-30954		744 880-2988
Automated multi-sample gas chromatog	graphic	Energy savings by means of fuel cell el	ectrodes in
analysis of fossil fuel gases	-0700 700 34506	electro-chemical industries	THE WOO 2000
[MLM-2721] Fossil fuels research matrix program	p0702 N80-31506	[COO-4881-12] po Aqueous trifluoromethanesulfonic acid f	1745 N80-3090.
Environmental Protection Agency/De			745 B80-3090
Energy Fossil Fuels Research Mater		Feasibility study for industrial cogene	
[ORNL/TM-7346]	p0583 N80-31632	cell application	
Pulse combustion technology for heat	ting applications		)746 N80-3093
	. p0707 N80-32467	Puel cells for electric utility and tra	nsportation
Combined cycle solar central receive system study. Volume 1: Executive		applications [BNL-27452] p0	747 N80-3093
[DOE/ET-21050/1-1]	p0586 N80-32867	Materials for fuel cells	,,4, 800 3033
Combined cycle solar central receive			748 N80-3095
system study, volume 2		Cell module and fuel conditioner	
[DOE/ET-21050/1-2]	p0586 N80-32868.		749 N80-3188
Combined cycle solar central receive		Coal processing for fuel cell utilizati	
system study. Volume 3: Appendic [DOR/ET-21050/1-3-VOL-3]	p0587 N80-32893	9: One-dimensional (streamtube) mode entrained-flow gasifier analysis	11 101
Constraints on carbon dioxide produc			707 N80-3191
fossil fuel use		Peasibility study: Puel cell cogenerat	
[ORAU/IEA-80-9 (H) ]	P0589 N80-32983	water pollution control facility, vol	
PACTURE MECHANICS	_		)749 N80-3192
A study of the heat-induced fracture characteristics of materials under		Fuel cell research on second-generation molten-carbonate systems	•
radiant heating	220000		750 N80-3193
• •	p0609 A80-46815	AC/DC power converter for batteries and	
RACTURE STREEGTE			750 H80-3193
Rotating strength of laminated compo		Development of molten carbonate fuel ce	ill power
RABCE	p0762 A80-47454	plant technology [DOB/RT-15440/1] p0	750 N80-3193
Aerospace technology transfer		Tests of a lightweight 200 kW BED chann	el and
[SNIAS-792-422-112]	p0579 N80-29210	diffuser	
REE BOUNDARIES			751 N80-3222
Bifurcation of sharp boundary beta=1		Modeling and evaluation of designs for	solid
equilibria plasma confinement	p0736 A80-49074	hydrogen storage beds [COMF-800616-8] p0	666 N80-3255
REE CONVECTION	p0/30 200 450/4	Direct electrochemical generation of el	
Measurement of natural convection in	a air-cooled	from coal	
solar collectors			752 180-3286
	p0627 A80-52834	Advanced technology fuel cell program	350 400 3003
REE REERGY Simultaneous photoproduction of hydr	roger and	[EPRI-BM-1328] p0 Development of an energy consumption an	752 N80-3287
oxygen by photosynthesis to co		base for fuel cell total energy syste	
energy into stored chemical free		conventional building energy systems	
[COMP-791072-32]	p0665 N80-30550	[ORNL/CON-38] p0	754 N80-3296
REE RADICALS		Assessment of environmental control tec	hnologies
Investigation of mechanisms of hydro	ogen transfer	for energy storage systems, 1979	1500 NON-3207
in coal hydrogenation, phase 2 [FE-2305-30]	p0710 N80-32568	[LA-0300-MS] p0 FURL COMBUSTION	1588 N80-3297
EFCOERCIES	P44 10 800-32300	Coal qasification in fluidized bed comb	ustion:
Tests of a lightweight 200 kW MHD ch	annel and	Status and developments - Future pers	
diffuser		· p0	669 A80-4526
[AD-A087022]	p0751 880-32226	One-dimensional model for pulverized co	al
URL CELIS	-100	combustion and gasification	669 A80-4532
The case for fuel-cell-powered vehic		טם	2007 AOUT4314.
Alternate synthesis of electrolyte	P0721 A80-47100	Cathode sheaths in potassium seeded MED plasmas	

p0721 A80-47135

FUEL CONSUMPTION SUBJECT INDEX

Comparative analysis of the basic combustion	
	Solar Central Receiver Hybrid Power Systems
characteristics of some heavy hydrocarbon fuels	sodium-cooled receiver concept. Volume 2, book
in application to aircraft gas turbine engines	1: Conceptual design, sections 1 through 4
p0721 A80-47424	[DOE/ET-20567/1-2-BK-1] p0645 B80-31896
Over 50% efficiency achieved in gas turbine system	Solar Central Receiver Hybrid Power Systems sodium-cooled receiver concept. Volume 2, book
using isothermal expansion p0724 A80-48249	2: Conceptual design, sections 5 and 6
Start-up consideration in utility use of a refuse	[DOB/BT-20567/1-2-BK-2] p0645 B80-31897
derived fuel	Interactions between energy supply and
p0673 A80-48276	transportation-related energy use, volume 1
Georgetown University's experience in the	[PB80-185002] p0584 H80-31968
atmospheric fluidized bed combustor technology	The energy efficient engine project
p0675 A80-48332	[ NASA-TM-81566] p0585 N80-32395
Catalytic combustion of hydrogen in model appliances	Reduction of fuel consumption by thermodynamic
p0662 A80-48415	optimization of the Otto motor: Comparative
Pluidized bed combustion of refuse derived fuels	investigation of Otto diesel engines
p0684 A80-50019	[EUR-6711-DE] p0585.880-32733
Sulfate in diesel exhaust	Potential of spark ignition engine, effect of
P0575 A80-50528	vehicle design variables on top speed,
Power generation from municipal and industrial	performance, and fuel economy
wastes with particular reference to sewage	[PB80-191836] p0586 H80-32736
combustion	Methanol/ethanol/gasoline blend fuels
.p0685 A80-50815	demonstration with stratified charge engine
The Utilisation of oil shale and lignite as low	vehicles
grade fuels in a cyclone furnace	[PB80-192123] . p0713 H80-33606
p0685 A80-50963	Cogeneration Technology Alternatives Study (CTAS).
Optimization problems of emission reduction in	Volume 6: Computer data. Part 2:
large fossil-fuel combustion facilities	Residual-fired nocogeneration process boiler
p0576 A80-51500	[NASA-CR-159770-PT-2] p0591 H80-33861
Aircraft Research and Technology for Puture Fuels	Working group on fuel consumption targets
[NASA-CP-2146] p0694 N80-29300	[NP-24333] p0591 N80-33910
The direct use of coal. Volume 2, part B:	PUBL PLON
<pre>Porking papers, appendices 7-9 { PB 80-184526 ]</pre>	Gas distribution equipment in hydrogen service - Phase II
[PB80-184526] p0697 B80-29521 Combustion of drops and sprays of no. 2 diesel oil	p0758 A80-48506
and its emulsions with water and methanol.	PORL OILS
Volume 1: Experimental	Investigation of fuels containing coal-oil-water
[PB80-178213] p0698 N80-30470	emulsions fire tube test apparatus
Combustion of drops and sprays of no. 2 diesel cil	[DOE/ET-10634/T1] p0691 H80-28552
and its emulsions with water and methanol.	Combustion of drops and sprays of no. 2 diesel oil
Volume 2: Theoretical	and its emulsions with water and methanol.
[PB80-178221] p0698 H80-30471	Volume 1: Experimental
Pulse combustion technology for heating applications	[PB80-178213] p0698 M80-30470
[ANL/RES/TH-85] p0707 H80-32467	Combustion of drops and sprays of no. 2 diesel oil
Soot reduction in diesel engines by catalytic	and its emulsions with water and methanol.
effects	Volume 2: Theoretical
[BNL-27792] p0585 N80-32731	[PB80-178221] p0698 N80-30471
FUEL CONSUMPTION	Process evaluation: Steam reforming of diesel
JT9D-7A /SP/ jet engine performance deterioration	fuel oil
trends	[AD-A087053] p0699 N80-30538
p0569 A80-44230	Recent coal-oil mixture combustion tests at PETC
Down to earth operations centralized	[DOE/PETC-TR-80/5] p0706 H80-31658
ground-based power distribution systems for	PUBL PRODUCTION
aircraft fuel savings	Highlights of the LLL Hoe Creek Ho. 3 underground coal gasification experiment
p0570 A80-46681	
Design considerations for a near-term hybrid vehicle	p0670 180-46606
p0571 A80-48420	p0670 180-46606 Energy from HSW - The industrial market
p0571 A80-48420 Energy conservation in terminal airspace through	p0670 A80-46606 Bnergy from MSW - The industrial market Municipal Solid Waste
p0571 A60-48420 Energy conservation in terminal airspace through fuel consumption modeling	p0670 A80-46606 Energy from MSW - The industrial market Municipal Solid Waste p0670 A80-47588
p0571 A80-48420 Energy conservation in terminal airspace through	p0670 A80-46606 Bnergy from MSW - The industrial market Municipal Solid Waste
p0571 A80-48420 Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695 Puture aviation fuels - The petroleum industry responds to the challenge	p0670 A80-46606 Energy from MSW - The industrial market Municipal Solid Waste  p0670 A80-47588 Hunicipal solid waste as an industrial fuel
p0571 &80-48420  Bnergy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 &80-49695  Puture aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 &80-49713	p0670 A80-46606 Energy from MSW - The industrial market Hunicipal Solid Waste  p0670 A80-47588 Hunicipal solid waste as an industrial fuel p0670 A80-47589
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum	p0670 A80-46606 Energy from MSW - The industrial market Hunicipal Solid Waste p0670 A80-47588 Hunicipal solid waste as an industrial fuel p0670 A80-47589 Wood energy systems - An assessment Energy from wood waste - A case study
p0571 A80-48420 Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695 Puture aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713 Impact of electric cars on U.S. petroleum consumption	p0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726	p0670 A80-46606  Energy from MSW - The industrial market Municipal Solid Waste p0670 A80-47588  Municipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar
p0571 A80-48420  Bnergy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Puture aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems	p0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization
p0571 A80-48420 Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695 Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713 Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726 The development of thermal energy storage systems exploiting solid-solid phase transitions	p0670 A80-46606  Energy from MSW - The industrial market Bunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization p0671 A80-47595
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970	p0670 A80-46606  Energy from MSW - The industrial market Municipal Solid Waste p0670 A80-47588  Municipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization p0671 A80-47595  Adapting geothermal energy to produce ethanol for
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Puture aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related	p0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D	p0670 A80-46606  Energy from MSW - The industrial market Bunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment  p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-48183
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines	p0670 A80-46606  Bnergy from MSW - The industrial market Bunicipal Solid Waste  p0670 A80-47588  Bunicipal solid waste as an industrial fuel p0670 A80-47589  Bood energy systems - An assessment  p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel p0723 A80-48183  The direction and scope of the U.S. Department of
Bnergy conservation in terminal airspace through fuel consumption modeling  [SAE PAPER 800745] p0573 A80-49695  Puture aviation fuels - The petroleum industry responds to the challenge  [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption  [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines  [DOE/CS-0154] p0693 H80-28571	p0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines [DOE/CS-0154] p0693 B80-28571  Electric and hybrid vehicle system research and	p0670 A80-46606  Energy from MSW - The industrial market Bunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment  p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothernal energy to produce ethanol for automotive fuel  p0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program p0672 A80-48242
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines [DOE/CS-0154] p0693 M80-28571  Electric and hybrid vehicle system research and development project, hybrid vehicle potential	p0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment  p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program p0672 A80-48242  Solar coal gasification
Bnergy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695 Puture aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713 Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726 The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970 Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines [DOE/CS-0154] p0693 M80-28571 Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis	p0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program p0672 A80-48242  Solar coal gasification
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines [DOE/CS-0154] p0693 M80-28571  Electric and hybrid vehicle system research and development project, hybrid vehicle potential	p0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment  p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program p0672 A80-48242  Solar coal gasification
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines [DOE/CS-0154] p0693 M80-28571  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis [COMS-4209-T1-VOL-6] p0583 M80-31274  Electric and hybrid vehicle system research and	p0670 A80-46606  Energy from MSW - The industrial market Bunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment  p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program p0672 A80-48242  Solar coal gasification  p0616 A80-48243  Plash pyrolysis and gasification of coal through laser heating
Bnergy conservation in terminal airspace through fuel consumption modeling  [SAE PAPER 800745] p0573 A80-49695  Puture aviation fuels - The petroleum industry responds to the challenge  [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption  [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines  [DOE/CS-0154] p0693 H80-28571  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis  [COBS-4209-T1-VOL-6] p0583 H80-31274  Electric and hybrid vehicle system research and development project, hybrid vehicle potential	p0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel p0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program p0672 A80-48242  Solar coal gasification p0616 A80-48243  Flash pyrolysis and gasification of coal through
p0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines [DOE/CS-0154] p0693 M80-28571  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis [COMS-4209-T1-VOL-6] p0583 M80-31274  Electric and hybrid vehicle system research and	Bnergy from MSW - The industrial market Hunicipal Solid Waste  P0670 A80-47588  Hunicipal solid waste as an industrial fuel P0670 A80-47589  Wood energy systems - An assessment P0670 A80-47593  Energy from wood waste - A case study P0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization P0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel P0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program P0672 A80-48242  Solar coal gasification P0616 A80-48243  Flash pyrolysis and gasification of coal through laser heating
Bnergy conservation in terminal airspace through fuel consumption modeling  [SAE PAPER 800745] p0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge  [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption  [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: B, D and D proposal guidelines  [DOE/CS-0154] p0693 H80-28571  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis  [COBS-4209-T1-VOL-6] p0583 H80-31274  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation  impact of hybrid vehicles on petroleum consumption  [COBS-4209-T1-VOL-8] p0583 H80-31275	P0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste  P0670 A80-47588  Hunicipal solid waste as an industrial fuel P0670 A80-47589  Wood energy systems - An assessment P0670 A80-47593  Energy from wood waste - A case study P0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization P0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel P0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program P0672 A80-48242  Solar coal gasification P0616 A80-48243  Flash pyrolysis and gasification of coal through laser heating P0672 A80-48244  Fast fluid bed coal gasification in a process development unit
P0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] P0573 A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] P0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] P0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines [D0E/CS-0154] P0693 B80-28571  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis [COBS-4209-T1-V0L-6] P0583 B80-31274  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [COBS-4209-T1-V0L-8] P0583 B80-31275  Plywheel energy management systems for improving	P0670 A80-46606  Energy from MSW - The industrial market Hunicipal Solid Waste  P0670 A80-47588  Hunicipal solid waste as an industrial fuel P0670 A80-47589  Wood energy systems - An assessment P0670 A80-47593  Energy from wood waste - A case study P0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization P0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel P0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program P0672 A80-48242  Solar coal gasification P0616 A80-48244  Flash pyrolysis and gasification of coal through laser heating P0672 A80-48244  Fast fluid bed coal gasification in a process development unit P0672 A80-48245  Historical development of the U-GAS process at the
P0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745]	Bnergy from MSW - The industrial market Bunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment  p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program p0672 A80-48242  Solar coal gasification  p0616 A80-48243  Flash pyrolysis and gasification of coal through laser heating  p0672 A80-48244  Fast fluid bed coal gasification in a process development unit  p0672 A80-48245  Historical development of the U-GAS process at the IGT pilot plant
Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695 Puture aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713 Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726 The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970 Alternative fuels, fuel additives and related devices for highway vehicles: B, D and D proposal guidelines [DOE/CS-0154] p0693 M80-28571 Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis [COMS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [COMS-4209-T1-VOL-8] p0583 M80-31275 Flywheel energy management systems for improving the fuel economy of motor vehicles [PB80-175300]	Bnergy from MSW - The industrial market Hunicipal Solid Waste  P0670 A80-47588  Hunicipal solid waste as an industrial fuel P0670 A80-47589  Wood energy systems - An assessment P0670 A80-47593  Energy from wood waste - A case study P0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization P0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel P0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program P0672 A80-48242  Solar coal gasification P0616 A80-48243  Flash pyrolysis and gasification of coal through laser heating P0672 A80-48244  Fast fluid bed coal gasification in a process development unit P0672 A80-48245  Historical development of the U-GAS process at the IGT pilot plant
P0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] Posta A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] Possa Paper 800108] Possa	Bnergy from MSW - The industrial market Bunicipal Solid Waste  p0670 A80-47588  Hunicipal solid waste as an industrial fuel p0670 A80-47589  Wood energy systems - An assessment  p0670 A80-47593  Energy from wood waste - A case study p0670 A80-47594  Peat and wood as fuels - Another form of solar energy utilization  p0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program p0672 A80-48242  Solar coal gasification  p0616 A80-48243  Flash pyrolysis and gasification of coal through laser heating  p0672 A80-48244  Fast fluid bed coal gasification in a process development unit  p0672 A80-48245  Historical development of the U-GAS process at the IGT pilot plant
Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695  Puture aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713  Impact of electric cars on U.S. petroleum consumption [SAE PAPER 800108] p0773 A80-49726  The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970  Alternative fuels, fuel additives and related devices for highway vehicles: E, D and D proposal guidelines [DOE/CS-0154] p0693 M80-28571  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis [COMS-4209-T1-VOL-6] p0583 H80-31274  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [COMS-4209-T1-VOL-8] p0583 H80-31275  Plywheel energy management systems for improving the fuel economy of motor vehicles [PB80-175300] p0777 M80-31278  Improved components for engine fuel savings [MASA-TE-81577] p0583 H80-31402	Bnergy from MSW - The industrial market Hunicipal Solid Waste  P0670 A80-47588  Hunicipal solid waste as an industrial fuel  P0670 A80-47589  Wood energy systems - An assessment  P0670 A80-47593  Energy from wood waste - A case study  P0670 A80-47594  Peat and wood as fuels - Another form of solar  energy utilization  P0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  P0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program  P0672 A80-48242  Solar coal gasification  P0616 A80-48243  Flash pyrolysis and gasification of coal through laser heating  P0672 A80-48244  Fast fluid bed coal gasification in a process development unit  P0672 A80-48245  Historical development of the U-GAS process at the IGT pilot plant  P0673 A80-48246
P0571 A80-48420  Energy conservation in terminal airspace through fuel consumption modeling [SAE PAPER 800745] Posta A80-49695  Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] Possa Paper 800108] Possa	Bnergy from MSW - The industrial market Hunicipal Solid Waste  P0670 A80-47588  Hunicipal solid waste as an industrial fuel  P0670 A80-47589  Wood energy systems - An assessment  P0670 A80-47593  Energy from wood waste - A case study  P0670 A80-47594  Peat and wood as fuels - Another form of solar  energy utilization  P0671 A80-47595  Adapting geothermal energy to produce ethanol for automotive fuel  P0723 A80-48183  The direction and scope of the U.S. Department of Energy's surface coal gasification program  P0672 A80-48242  Solar coal gasification  P0616 A80-48243  Flash pyrolysis and gasification of coal through laser heating  P0672 A80-48244  Fast fluid bed coal gasification in a process development unit  P0672 A80-48245  Historical development of the U-GAS process at the IGT pilot plant  P0673 A80-48246

SUBJECT INDEX FUEL PRODUCTION CONTD

Status of nuclear high temperature process heat development in the Federal Republic of Germany /coal gasification and long distance energy transport/

D0758 A80-48311 Design of the HTGR for process heat applications p0758 A80-48313 Permentation ethanol as a petroleum substitute p0675 A80-48324

The role of refuse derived fuel /RFD/ as an alternative energy source for district heating and power generation

p0675 A80-48331 Projected costs for electricity and products from OTEC facilities and plantships

p0728 A80-48349 Overview of high efficiency power cycles for fusion p0728 A80-48358 Advanced process development in coal liquefaction p0676 180-48379

Disposable catalysts in the solvent refined coal processes

PO676 A80-48381 Perspective on the DOB fusion synthetic fuels

p0677 A80-48402 The fusion-synfuel tie producing hydrogen with the Tandem Mirror Reactor

p0662 180-48403 Scoping study of a tandem-mirror fusion reactor coupled to a thermochemical hydrogen synfuel plant p0662 A80-48406

The Department of Energy's major project coal liquefaction program

p0677 A80-48427 Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program

p0677 A80-48428 H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal

p0677 180-48429 Bxxon Donor Solvent Coal Liquefaction Process -Development Program Status

p0677 A80-48430 LC-Fining of solvent refined coal - SBC-I and short contact time coal extracts --- Lumnus Cities Fining catalytic hydrogenation process p0678 A80-48431

Heat transfer in slurry preheaters for coal liquefaction plants

p0678 A80-48432 Development of a falling-bed fusion blanket system for synthetic fuel production

D0678 A80-48447 HIFIRE - Pusion-high temperature electrolysis system p0731 A80-48448

High-temperature fusion blanket for a synthetic fuel plant

p0663 A80-48451 Investing in coal --- international energy policy p0572 A80-49391

The flash hydropyrolysis of lignite and sub-bituminous coals to both liquid and gaseous hydrocarbon products

p0679 A80-49626 Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves

p0679 A80-49627 Qualitative and quantitative assessment of reaction models of coal hydrogenation

p0679 A80-49629 Selectivity improvement in the solvent refined coal process. I - Detailed first-stage reaction studies - Coal mineral catalysis. II - Detailed second-stage reaction studies - Hydrotreating of coal liquids

Puture aviation fuels - The petroleum industry

responds to the challenge [SAE PAPER 800769] [SAR PAPER 800769] p0680 A80-49713 Environmental impact of conversion of refuse to energy

p0574 A80-49954 The combined firing of coal and waste derived fuel in steam raising plant

p0681 A80-49956

The combustion engineering approach to municipal solid waste energy recovery

n0681 A80-49959 Biogas from residues of animal husbandry and

agricultural plant production p0683 A80-49994 The Wetox process for energy recovery from sewage sludge and industrial waste streams

p0683 A80-49998 Economic and technical evaluation of the Ames,
Icwa solid waste recovery system

p0683 A80-50005 Energy recycling through refuse pelletizing P0683 A80-50008

Chemical fuel and raw material production by thermal processing of refuse - Technology and

p0684 A80-50010 Brini - A completion to solid fuels -- municipal solid wastes conversion

p0684 A80-50017 Co-firing densified refuse derived fuel in a spreader stoker fired boiler

D0684 A80-50018

Waste oil as a fuel p0684 A80-50032

New directions in energy recovery from petroleum refinery oily sludges

p0685 A80-50034

Fuel gas from used tyres by means of the Babcock-Pohrbach process p0685 A80-50036

Potentialities and limitations of future use of coal for power generation

D0685 A80-50817 Global model of countercurrent coal gasifiers

p0686 A80-51571 Alcohol fuels for spaceship earth

p0686 A80-51953 Wood fuel production experiments in Sweden p0687 A80-52854

The Brazilian National Alcohol Programme Po687 A80-52855 Research, development, and commercialization

activities on biomass energy in the United States

p0687 A80-52857 The potential role of biofuels within the built environment

p0688 A80-53474 Aircraft Research and Technology for Future Fuels p0694 #80-29300 Outlook for alternative energy sources

aviation fuels n0694 N80-29302

Current jet fuel trends D0694 N80-29303

Aviation fuels outlook p0694 N80-29304

Effect of refining variables on the properties and composition of JP-5 p0694 N80-29306

Military jet fuel from shale oil

p0694 N80-29308 Production of synthetic liquids from coal, 1980 -2000. Preliminary study of potential impediments [ FE-3137-T1 ] p0696 N80-29510

Research and development of an advanced process for the conversion of coal to synthetic gasoline and other distillate fuels

[FE-2306-38] p0696 880-295

[FE-2306-38] p0696 M80-29513 Coordinating fossil fuel research in natural gas

recovery [ PB80-169469] p0697 N80-29527

Overview of nuclear fuel cycle [CONF-791185-3]

Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes. Laboratory and pilot plant studies of the

processing of SRC-1 p0699 B80-30544 [ PE-2315-45 ] Molten salt coal gasification process development

unit [ SAN-1429-52 ] Advanced coal gasification system for electric

power generation [FE-1514-101] D0703 N80-31634 Interactions between energy supply and

transportation-related energy use, volume 1 p0584 #80-31968 f FB80-1850021

Oversight: Alternate liquid fuels technology [GPO-50-313] p0590 880-33580	Energy conversion considerations of the STARFIRE commercial fusion power plant
PUEL SPEATS	p0733 A80-4849
Combustion of drops and sprays of no. 2 diesel oil and its emulsions with water and methanol.	The Engineering Test Facility - The next major development in the U.S.A. fusion program
Volume 1: Experimental [PB80-178213] p0698 880-30470	p0733 A80-4849 The reversed-field pinch fusion reactor
Combustion of drops and sprays of no. 2 diesel cil and its emulsions with water and methanol.	p0733 A80-4849 TRACT -A small fusion reactor based on near-term
Volume 2: Theoretical	engineering
[PB80-178221] p0698 H80-30471 PURL SYSTEMS	The Spheromak fusion reactor
Investigation of the feasibility of methanol as an automobile fuel	p0733 A80-4849 Application of the fusion reactor to
p0688 A80-52881	thermochemical-electrochemical hybrid cycles and
Potential of diesel engine, 1979 summary source	electrolysis for hydrogen production from water
document [PB80-193659] p0585 N80-32734	p0664 A80-5146 Pusion reactors for hydrogen production via
Potential of diesel engine, emission technology	electrolysis
[PB80-192685] p0586 N80-32735	[BNL-27782] p0667 N80-3255
POBL TESTS  Co-firing densified refuse derived fuel in a	Fusion: An energy source for synthetic fuels [BNL-27891] p0667 N80-3320
spreader stoker fired boiler	Systems assessment of heavy ion beam fusion drivers
p0684 A80-50018 Advanced combustion systems for stationary gas	[DOE/DP-40039] . p0754 N80-3324
turbine engines. Volume 4: Combustor	Ğ
verification testing, addendum [PB80-179849] p0698 B80-30313	GALLIUM ARSENIDES
Performance of a diesel engine operating on raw	Concentration and temperature performances of
coal-diesel fuel and solvent refined coal-diesel fuel slurries	Gals-Gallas solar cells
[COES-3288-T6] p0701 H80-30758	p0603 A80-4673 Efficient GaAs shallow-homojunction solar cells on
Aviation turbine fuels, 1979	single-crystal Gals and Ge substrates
[DOE/BETC-PPS-80/2] p0703 H80-31627  Effects of gasohol on idle HC and CO emissions	p0608 A80-4678 On the influence of an interfacial oxide layer on
' [PB80-190655] p0590 N80-33018	Au/n-Gals Schottky barrier solar cells
PUBLS	p0608 A80-4678
Alternative fuels, fuel additives and related devices for highway vehicles: R, D and D	20 kW gallium arsemide photovoltaic dense array for central receiver concentrator applications
proposal guidelines	p0608 A80-4679
[DOE/CS-0154] p0693 N80-28571	Radiation effects on solar cells
Municipal refuse as a fuel for power generation p0714 N80-33950	p0609 180-4689 High-efficiency AlGals/Gals concentrator solar
Otilization of municipal refuse as an energy source	cells by organometallic wapor phase épitamy
PULL SCALE TESTS p0714 N80-33952	p0610 180-4695. Gals solar cells for space applications
Life cycle test of Air Porce mickel-hydrogen	p0613 A80-4820
flight experiment battery p0771 A80-48443	Effects of thermal annealing on the deep-level defects and I-V characteristics of 200 keV
PURBACES .	proton irradiated AlGahs-Gahs solar cells
Design study of a coal-fired thermionic	p0613 A80-4820
/THI/-topped power plant p0730 180-48422	Gallium arsemide solar cells for use in concentrated sunlight
The utilisation of oil shale and lignite as low	p0628 A80-5286
grade fuels in a cyclone furnace p0685 180-50963	Conceptual design study of concentrator enhanced solar arrays for space applications. 2kW Si and
PUSION (MELTING)	Gals systems at 1 AU
Note on the condensation of the vapor phase above a melt of iron oxide in a solar parabolic	. [NASA-CE-163046] p0630 N80-2886. Gallium arsenide solar cells for very high
concentrator	concentration systems: Recent results, problems
FUSION REACTORS PO611 A80-47664	and expectations [CISE-1518] p0649 #80-3196
The feasibility of pellet re-fuelling of a fusion	[CISE-1518] p0649 B80-3196. Satellite Power Systems (SPS) concept definition
reactor	study. Volume 6: In-depth element investigation
p0719 A80-44661 The Tandem Mirror Fusion Test Facility	[MASA-CR-3323] p0651 M80-3285 Gallium arsenide photovoltaic dense array for
p0720 A80-45850	concentrator applications
Overview of high efficiency power cycles for fusion p0728 A80-48358	[SAND-80-1569C] p0654 N80-32930 Gallium arsenide photovoltaic dense array for
Advanced power technology for fusion reactors	concentrator applications
p0728 A80-48359 Direct energy conversion for fusion power	[SAND-79-2270C] p0655 N80-3293
p0729 A80-48361	Development of space-qualified Gals solar cells p0658 B80-3388
The fusion-synfuel tie producing hydrogen with the Tandem Mirror Reactor	GARBAGE An analysis of criteria for evaluating proposals
p0662 A80-48403	for recovery of material and energy from refuse
Interfacing the Tandem Birror Reactor to the sulfur-iodine process for hydrogen production	p0574 A80-4993 Status report on the research programme 'New
p0662 A80-48404	processes of thermal waste treatment'
Scoping study of a tandem-mirror fusion reactor	p0680 A80-4993
coupled to a thermochemical hydrogen synfuel plant p0662 A80-48406	The conversion of refuse into energy within a regional context
High-temperature thermochemical water splitting	. p0680 A80-4993
cycle fusion reactor design considerations p0663 A80-48449	GAS ANALYSIS Use of an automated mass spectrometer for an
Present and future status of thermochemical cycles	underground coal gasification field test
applied to fusion energy sources p0663 180-48450	[UCRL-84366] p0709 N80-3256
Page 2 200-40420	

SUBJECT INDEX GASIFICATION

	· ,
GAS CHROMATOGRAPHY	GAS TUBBINES
Automated multi-sample gas chromatographic	A 150 MW power generating gas turbine plant
analysis of fossil fuel gases [NLB-2721] p0702 H80-31506	p0719 A80-44773 The behavior of a closed-cycle gas turbine with
GAS COOLING  Closed-cycle gas turbines for power generation and	time dependent operating conditions [ASME PAPER 79-GT/ISR-2] p0720 A80-45663
LNG vaporization p0739 A80-52600	Closed-cycle helium gas turbine for solar tower power plant
GAS EXPLOSIONS  Vapor cloud explosion studies in the United States	[ONERA, TP NO. 1980-28] p0597 A80-46228 Thermodynamic analysis of the helium cycles of gas
p0590 #80-33595 GAS PLOW	turbine nuclear power plants
Plue gas recirculation as a means of improving the solid waste incineration process	p0721 A80-47080 Over 50% efficiency achieved in gas turbine system using isothermal expansion
p0688 A80-53057	p0724 A80-48249
GAS GEBERATORS  Design and operation of fluidised bed industrial  boilers and hot gas producers	Thermionic topping of combined cycle powerplants and cogeneration applications p0730 A80-48423
p0672 A80-48202 Relp processing and biomethanation technology	Closed-cycle gas turbines for power generation and LNG vaporization
p0673 A80-48278 Development status of the General Electric solid	p0739 A80-52600 Worldwide survey of current experience burning
polymer electrolyte water electrolysis technology p0662 180-48413	residual and crude oils in gas turbines [BPRI-AF-1243] p0693 N90-28724
GAS HEATING  Development of the high temperature air heater for	Development of high-temperature turbine subsystem technology to a technology readiness status,
open cycle MHD p0724 A80-48224	phase 2 [PE-1806-67] p0693 B80-28726
An investigation of simultaneous heat and mass transfer in subbituminous coal hot gas	Development of high-temperature turbine subsystem technology to a technology readiness status,
drying for underground coal conversion p0676 A80-48344	phase 2 [FE-1806-86] p0701 N80-30753
GAS RECOVERY	Cogeneration Technology Alternatives Study (CTAS).
Wood waste gasification as a source of energy p0679 A80-49540	Volume 3: Energy conversion system characteristics
Design of land-based, foam OTEC plants for bottoming cycles	[NASA-CR-159761] p0748 N80-31869 Combined cycle solar central receiver hybrid power
[CONF-790631-17] p0742 N80-28913	system study. Volume 3: Appendices
Coordinating fossil fuel research in natural gas recovery	[DOE/ET-21050/1-3-VOL-3] p0587 N80-32893 GAS-NETAL INTERACTIONS
[PB80-169469] p0697 W80-29527 US Department of Energy's methane from landfills	Hydrogen storage in magnesium powder p0664 A80-50623
program ( [CONF-7910126-1] p0701 N80-30558	GAS-SOLID INTERPACES Single particle gas-solid reactions and their
Cryogenic methane separation/catalytic	application to modeling of fluidized bed coal
hydrogasification process analysis [FB-3044-T7] p0704 H80-31635	combustors and ash agglomerating gasifiers p0713 N80-33578
GAS STREAMS	GASBOUS FUELS
Condensation processes in coal combustion products [DOE/ER-10456/1] p0708 N80-32473 GAS TURNING ENGINES	Coal gasification in fluidized bed combustion: Status and developments - Future perspectives p0669 A80-45267
Status of the Ford program to evaluate ceramics for stator applications in automotive gas	One-dimensional model for pulverized coal combustion and gasification
turbine engines p0720 180-45375	p0669 A80-45322 Highlights of the LLL Hoe Creek No. 3 underground
On calculating gas turbine efficiency reduction under the influence of air cooling	coal gasification experiment
p0721 180-47415 Comparative analysis of the basic combustion	Methane recovery from urban refuse p0670 A80-47587
characteristics of some heavy hydrocarbon fuels in application to aircraft gas turbine engines	The direction and scope of the U.S. Department of Energy's surface coal gasification program
p0721 A80-47424 The HTGR-GT closed-cycle gas turbine - A plant	p0672 A80-48242 Solar coal gasification
concept with inherent cogeneration /power plus heat production/ capability	p0616 A80-48243 Plash pyrolysis and gasification of coal through
p0724 A80-48248 An automotive transmission for automotive gas	laser heating p0672 A80-48244
turbine power plants [SAE PAPER 800099] p0736 A80-49724	Past fluid bed coal gasification in a process development unit
Gas turbines for automotive use Book p0736 180-50351	Bistorical development of the U-GAS process at the
The solution to the gas turbine temperature problem engine design p0738 A80-50949	IGT pilot plant p0673 A80-48246 Over 50% efficiency achieved in gas turbine system
Ceramics for turbine engine applications	using isothermal expansion
[AGARD-CP-276] p0743 N80-29342 Requirements for materials for land vehicle gas turbines	p0724 A80-48249 Use of gas from landfills for energy recovery - Operating experience at Palos Verdes
p0743 H80-29345 Some advantages of methane in an aircraft gas	p0683 A80-49999 Fuel gas from used tyres by means of the
turbine [NASA-TM-81559] p0695 N80-29502	Babcock-Rohrbach process p0685 A80-50036
Advanced combustion systems for stationary gas turbine engines. Volume 2: Bench scale	Global model of countercurrent coal gasifiers p0686 A80-51571
evaluation [PB80-175607]  Opgraced automotive gas turbine engine design and .	GASIFICATION  Status of peat biogasification development p0674 A80-48293
development program, volume 2 [NASA-CE-159671] p0751 N80-32719	

Don't shar sosification - Inhoratory and DDU-seals	liganting conthernal common to amodumo ottomol for
Peat char gasification - Laboratory and PDU-scale	Adapting geothernal energy to produce ethanol for
studies Process Development Unit	automotive fuel
p0674 180-48294	p0723 A80-48183
Liquid products from peat pyrolysis	Heat pumps in low temperature applications
p0677 A80-48385	using geothermal resources
Wood waste gasification as a source of energy	p0723 A80-48184
p0679 A80-49540	Condenser designs for binary power cycles in
Biomass gasification processes	geothermal energy conversion
p0682 A80-49578	p0723 A80-48221
The gasification of municipal and industrial waste	Simulation of mass transfer processes in
in accordance with the SPW-FUNK-Process	geothermal power cycles with direct contact heat
p0682 A80-49979	exchange
Survey of biomass gasification. Volume 3:	p0724 A80-48222
Current technology and research	Power production from geothermal brine with the
[SERI/TR-33-239-VOL-3] p0705 H80-31648	rotary separator turbine
Biomass energy production. Citations from the	p0725 A80-48266
International Aerospace Abstracts data base	Generalized performance predictions for energy
[PB80-810807] p0711 N80-32578	conversion plants using geogressured geothermal
Solar gasification of charcoal, wood and paper	fluids
· [UCRL-84411] p0654 880-32926	p0725 A80-48268
GASOBOL (PUBL)	Raft River 5-MW/e/ geothermal pilot plant
Alcohol fuels for spaceship earth	p0727 A80-48314
p0686 A80-51953	The challenge of financing geothermal development
. First report to Congress on the use of alcohol in	p0727 A80-48317
motor fuels	Geothermal energy - An overview
[DOE/CS-0165] p07C8 N80-32548	p0737 A80-50907
Effects of gasohol on idle EC and CO emissions	Environmental constraints on geothernal energy
[PB80-190655] p0590 N80-33018	[ORNL-1310] p0580 N80-29868
Methanol/ethanol/gasoline blend fuels	Energy analysis of geothernal-electric systems
demonstration with stratified charge engine	[COO-5085-4] p0584 N80-31915
vehicles	Heat pumps in low temperature applications
[PB80-192123] p0713 N80-33606	[CONF-800806-7] p0711 N80-32699
GASOLINE	Model of direct contact heat transfer for latent
Mobil methanol-to-gasoline process	heat energy storage
p0677 A80-48384	[SERI/TP-631-567] p0779 N80-32955
Electric and hybrid vehicle system research and	Assessment of H2S control technologies for
development project, hybrid vehicle potential	geothermal power plants
assessment. Volume 8: Scenario generation	[PB80-193709] p0593 N80-33973
impact of hybrid vehicles on petroleum consumption	GEOTHERMAL BURBGY EXTRACTION
[CONS-4209-11-VOL-8] p0583 N80-31275	Preliminary study of the potential environmental
First report to Congress on the use of alcohol in	concerns associated with surface waters and
notor fuels	geothermal development of the Valles Caldera
[DOB/CS-0165] p0708 880-32548	[LA-8398-MS] p0592 M80-33969
Modifications for use of methanol or	GROTHRREAT, RERRGY UTIT, TRATTON
Modifications for use of methanol or methanol-gasoline blends in automotive vehicles	GEOTHERNAL EMERGY UTILIZATION Use of geothernal energy in the eastern United
methanol-gasoline blends in automotive vehicles	Use of geothermal energy in the eastern United
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552	Use of geothernal energy in the eastern United States
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552 Effects of gasohol on idle BC and CO emissions	Use of geothermal energy in the eastern United States p0685 A80-50908
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552 Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018	Use of geothermal energy in the eastern United States p0685 A80-50908 GEOTHERMAL RESOURCES
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 N80-33018  Evaluation of processes for producing gasoline	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 N80-33018  Evaluation of processes for producing gasoline from wood	Use of geothermal energy in the eastern United States p0685 A80-50908  GEOTHERMAL RESOURCES p0669 A80-46170
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics  p0669 A80-46170  Analysis of binary thermodynamic cycles for a
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource
methanol-gasoline blends in automotive vehicles [ALO-3682-T1]  Effects of gasohol on idle HC and CO emissions [PB80-190655]  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2]  GELS  Study of gelled LNG characterization of gelled	Use of geothermal energy in the eastern United States p0685 A80-50908  GEOTHERMAL RESOURCES p0669 A80-46170 Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267
methanol-gasoline blends in automotive vehicles [NLO-3682-T1] p0708 N80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 N80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics  p0669 A80-46170  Analysis of binary thermodynamic cycles for a  moderately low-temperature geothermal resource  p0725 A80-48267  Electric power generation using low temperature  geothermal resources and wood residues
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506  GROLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Bawaii Geothermal Project 'A' wellhead generator feasibility project
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Bvaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BV-02057/T2] p0695 M80-29506  GROLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Elawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS  Landsat imagery in oil exploration - Six years of experience  p0685 A80-50880  Application of remote sensing techniques to	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 N80-33018  Bvaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BV-02057/T2] p0695 N80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience  p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BY-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS  Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEOLOGEPHOLOGY	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOurces  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience  p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908  A problem posed by vapour-dominated geothermal systems
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS  Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOurces  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908  A problem posed by vapour-dominated geothermal systems
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Bvaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHISICS	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BY-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY  Application of remote sensing techniques to petroleum exploration in India  GEOPHYSICS Electromagnetic methods in applied geophysics	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908  A problem posed by vapour-dominated geothermal systems p0689 A80-54063  Hagma energy: A feasible alternative [SAND-E0-0309] p0683 N80-28874
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS  Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOPHISICS Electromagnetic methods in applied geophysics p0669 A80-46170	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908 A problem posed by vapour-dominated geothermal systems p0689 A80-54063  Magma energy: A feasible alternative [SAND-E0-0309] p0693 N80-28874 Geological and geothermal data use investigations
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 M80-33018  Bvaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEOPHISICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSTECHEOBOUS ORBITS	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [P880-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [D0E/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [D0E/EV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOPHYSICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSTECHEOMOUS OBBITS An accelerated test design for use with	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908  A problem posed by vapour-dominated geothermal systems p0689 A80-54063  Hagma energy: A feasible alternative [SAND-E0-0309] Geological and geothermal data use investigations for application Explorer mission-A (heat capacity mapping mission)
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS  Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEOPHISICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSINCHBONOUS ORBITS An accelerated test design for use with synchronous orbit on Ni-Cd cell degradation	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOurces  Rectromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908  A problem posed by vapour-dominated geothermal systems p0689 A80-54063  Magma energy: A feasible alternative [SAND-E0-0309] p0693 N80-28874  Geological and geothermal data use investigations for application Explorer mission-A (heat capacity mapping mission) [E80-10279] p0698 N80-29822
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 N80-33018  Bvaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2] p0695 N80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEOPHISICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSIECHEOHOUS ORBITS An accelerated test design for use with synchronous orbit on Ni-Cd cell degradation behavior	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle BC and CO emissions [P880-190655] p0590 N80-33018  Evaluation of processes for producing gasoline from wood [D0E/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [D0E/EV-02057/T2] p0695 N80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908  A problem posed by vapour-dominated geothermal systems p0689 A80-54063  Magma energy: A feasible alternative [SAND-E0-0309] Geological and geothermal data use investigations for application Explorer mission-A (heat capacity mapping mission) [E80-10279] Hydrothermal energy: A source of energy for alcohol production
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BV-02057/T2] p0695 M80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOPHYSICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSTECHEOMOUS ORBITS An accelerated test design for use with synchronous orbit on Mi-Cd cell degradation behavior  p077C A80-48401	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 M80-33018  Bvaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 M80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BV-02057/T2] p0695 M80-29506  GROLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  D0686 A80-51088  GEOPHISICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSIECHEOHOUS ORBITS An accelerated test design for use with synchronous orbit on Mi-Cd cell degradation behavior  D077C A80-48401  Synchronous Energy Technology [MASA-CP-2154] p0656 880-33465	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle EC and CO emissions [P880-190655] p0590 N80-33018  Evaluation of processes for producing gasoline from wood [D0E/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [D0E/EV-02057/T2] p0695 N80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOPEYSICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSTECHEOHOUS ORBITS An accelerated test design for use with synchronous orbit on Ni-Cd cell degradation behavior p077C A80-48401  Synchronous Energy Technology [NASA-CP-2154] p0656 N80-33465 Synchronous energy technology program	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics  p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource  p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues  p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project  p0727 A80-48316  Geothermal energy - An overview  p0737 A80-50907  Use of geothermal energy in the eastern United States  p0685 A80-50908  A problem posed by vapour-dominated geothermal systems  p0689 A80-54063  Hagma energy: A feasible alternative  [SAND-E0-0309]  Geological and geothermal data use investigations for application Explorer mission-A (heat capacity mapping mission)  [E80-10279]  Bydrothermal energy: A source of energy for alcohol production  [CONF-800526-1]  Environmental data, energy technology characterizations: Geothermal
methanol-gasoline blends in automotive vehicles [ALO-3682-T1]  Effects of gasohol on idle HC and CO emissions [PB80-190655]  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2]  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2]  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience  Application of remote sensing techniques to petroleum exploration in India  GEOHORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOPHYSICS Electromagnetic methods in applied geophysics p0669 A80-51088  GEOPHYSICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSIECHEOBOUS ORBITS An accelerated test design for use with synchronous orbit on Ni-Cd cell degradation behavior  Synchronous Energy Technology [NASA-CP-2154] Synchronous energy technology program p0657 880-33466	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Hawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908  A problem posed by vapour-dominated geothermal systems p0689 A80-54063  Hagma energy: A feasible alternative [SAND-E0-0309]  Geological and geothermal data use investigations for application Explorer mission-A (heat capacity mapping mission) [E80-10279] p0698 N80-29822  Hydrothermal energy: A source of energy for alcohol production [CONF-800526-1] p0698 N80-29869  Environmental data, energy technology characterizations: Geothermal p0580 N80-29912
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle EC and CO emissions [P880-190655] p0590 N80-33018  Evaluation of processes for producing gasoline from wood [D0E/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [D0E/EV-02057/T2] p0695 N80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOPEYSICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSTECHEOHOUS ORBITS An accelerated test design for use with synchronous orbit on Ni-Cd cell degradation behavior p077C A80-48401  Synchronous Energy Technology [NASA-CP-2154] p0656 N80-33465 Synchronous energy technology program	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle BC and CO emissions [P880-190655] p0590 N80-33018  Bvaluation of processes for producing gasoline from wood [D0E/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [D0E/BY-02057/T2] p0695 N80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOPEYSICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSTECHEOHOUS OBBITS An accelerated test design for use with synchronous orbit on Ni-Cd cell degradation behavior p077C A80-48401  Synchronous Energy Technology [MASA-CP-2154] p0656 N80-33466 Photovoltaic technology development for synchronous orbit	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Bawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908  A problem posed by vapour-dominated geothermal systems p0689 A80-54063  Magma energy: A feasible alternative [SAND-E0-0309] Geological and geothermal data use investigations for application Explorer mission-A (heat capacity mapping mission) [E80-10279] Bydrothermal energy: A source of energy for alcohol production [CONF-800526-1] Environmental data, energy technology characterizations: Geothermal [DOE/EV-0077] Cogeneration Technology Alternatives Study (CTAS). Volume 6: Computer data. Part 1: Coal-fired
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 N80-33018  Bvaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BV-02057/T2] p0695 N80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOPHYSICS Electromagnetic methods in applied geophysics p0686 A80-51088  GEOSTECHEOHOUS OBBITS An accelerated test design for use with synchronous orbit on Bi-Cd cell degradation behavior  p077C A80-48401  Synchronous Energy Technology [NASA-CP-2154] Synchronous energy technology program p0657 N80-33466  Photovoltaic technology development for	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics p0669 A80-46170  Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource p0725 A80-48267  Electric power generation using low temperature geothermal resources and wood residues p0675 A80-48315  Bawaii Geothermal Project 'A' wellhead generator feasibility project p0727 A80-48316  Geothermal energy - An overview p0737 A80-50907  Use of geothermal energy in the eastern United States p0685 A80-50908  A problem posed by vapour-dominated geothermal systems p0689 A80-54063  Magma energy: A feasible alternative [SAND-E0-0309] p0693 N80-28874  Geological and geothermal data use investigations for application Explorer mission-A (heat capacity mapping mission) [E80-10279] p0698 N80-29822  Hydrothermal energy: A source of energy for alcohol production [CONF-800526-1] p0698 N80-29869  Environmental data, energy technology characterizations: Geothermal [DOE/EV-0077] P0580 N80-29812  Cogeneration Technology Alternatives Study (CTAS). Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section A
methanol-gasoline blends in automotive vehicles [ALO-3682-T1]  Effects of gasohol on idle HC and CO emissions [PB80-190655]  Evaluation of processes for producing gasoline from wood [DOE/PE-70048/T2]  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/EV-02057/T2]  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience  Application of remote sensing techniques to petroleum exploration in India  GEOHORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEOPHYSICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSIECHEONOUS OBBITS An accelerated test design for use with synchronous orbit on Ni-Cd cell degradation behavior  Synchronous Energy Technology [NASA-CP-2154] Synchronous energy technology program  P0657 N80-33466 Photovoltaic technology development for synchronous orbit  P0657 N80-33470	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 N80-33018  Bvaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BY-02057/T2] p0695 N80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India  p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques p0686 A80-51088  GEONORPHOLOGY Application of remote sensing techniques p0686 A80-51088  GEONORPHOLOGY Application of remote sensing	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552  Effects of gasohol on idle BC and CO emissions [P880-190655] p0590 N80-33018  Bvaluation of processes for producing gasoline from wood [DOE/PE-70048/T2] p0713 N80-33602  GELS  Study of gelled LNG characterization of gelled LNG with respect to process, flow, use properties, and safety [DOE/BY-02057/T2] p0695 N80-29506  GEOLOGICAL SURVEYS Landsat imagery in oil exploration - Six years of experience p0685 A80-50880  Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOMORPHOLOGY Application of remote sensing techniques to petroleum exploration in India p0686 A80-51088  GEOPEYSICS Electromagnetic methods in applied geophysics p0669 A80-46170  GEOSTECHEOHOUS OBBITS An accelerated test design for use with synchronous orbit on Ni-Cd cell degradation behavior p077C A80-48401  Synchronous Energy Technology [MASA-CP-2154] p0656 N80-33466  Photovoltaic technology development for synchronous orbit p0657 N80-33470  Large solar arrays	Use of geothermal energy in the eastern United States  p0685 A80-50908  GEOTHERMAL RESOURCES  Electromagnetic methods in applied geophysics

SUBJECT INDEX HEAT EXCHANGERS

Cogeneration Technology Alternatives Study (CTAS).
Volume 6: Computer data. Part 2:
Residual-fired nocogeneration process boiler GRAVITATIONAL EPPECTS Experimental investigation of systems for diminishing the structural loads of large wind [NASA-CR-159770-PT-2] p0745 N80-30890 turbines Remote sensing applied to the prospecting of geothermal anomaly in Caldas Novas County, State p0722 A80-47600 A problem posed by vapour-dominated geothermal of Goias, Brazil [INPE-1792-BPE/164] systems p0712 N80-32837 p0689 A80-54063 Energy programs at the Johns Hopkins University
Applied Physics Laboratory
[PB80-195316] p0783 N80-Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of p0783 N80-33919 Preliminary study of the potential environmental concerns associated with surface waters and geothermal development of the Valles Caldera attack and flapping being coupled [ISD-244] GREEHOUSE EFFECT p0747 N80-30949 Supplementary material on passive solar heating concepts: A compilation of published articles. Presented in conjunction with a series of passive solar heating seminars sponsored by the [LA-8398-MS] p0592 N80-33969 A multi-site magnetotelluric measurement system with real time data analysis D0714 N80-33988 GEOTHERNAL TECHNOLOGY [PNL-SA-7820]
GRIDS Solar Energy Technology Transfer program The Federal Geothermal Energy Program p0642 N80-30920 D0723 A80-48182 Geothernal energy - An overview Predicted effect of grid line aspect ratio on the performance of solar cells P0737 A80-50907 Patent profiles: Solar energy
[PB80-190010] p0649 1
Proceedings of the Ocean Energy Information p0625 A80-51687 p0649 N80-31966 GROUND SUPPORT ROUIPMENT Down to earth operations --- centralized ground-based power distribution systems for Dissemination Workshop [SERI/TP-732-600] p0753 N80-32956 aircraft fuel savings GERMANIUM p0570 A80-46681 Efficient GaAs shallow-homejunction solar cells on GROUND SUPPORT SYSTEMS single-crystal GaAs and Ge substrates Bybrid lithium/nickel-zinc large missile ground p0608 A80-46783 power source GRRMANIUM ALLOYS D0772 A80-48489 Evaluation of multijunction structures using GROUND TESTS amorphous Si-Ge alloys --- for solar cells Application of battery reconditioning techniques to achieve capacity restoration - A case history --- Ni-Cd cell performance improvement for spacecraft applications D0602 A80-46719 GERMANY Composite rotor blades for large wind energy installations p0769 A80-48397 GROUND WIND [ NASA-TM-75822 ] D0749 N80-31881 Sites for wind-power installations: Physical GIMBALS Research and development for inertial energy . modeling of the influence of hills, ridges and storage based on a flexible flywheel [SAND-79-7097] complex terrain on wind speed and turbulence. Part 1: Executive summary p0778 N80-32898 [RLO-2438-78/1] GLASS p0706 N80-31900 Properties of a solar alumina-borosilicate sheet Changes in the potential for wind energy generation due to terrain modification of the [SERI/TP-334-565] boundary-layer flow p0641 N80-30530 Cleaning agents and techniques for concentrating solar collectors
[SAND-79-7052] p0659 N80-3 p0714 N80-34020 GUST LOADS Combined effects of periodic and stochastic loads on the fatigue of wind turbine parts, part 6 [PPN-NU-1499-PT-6] p0741 N80-28732 p0659 N80-33911 GLASS BLECTRODES Photoelectrochemical conversion using reaction-centre electrodes GUSTS p0596 A80-45504 Definition of gust model concept and review of GLASS PIBERS gust models [PNL-3138] Composite rotor blades for large wind energy p0712-N80-33072 installations [NASA-TM-75822]
GOVERNMENT/INDUSTRY RELATIONS D0749 N80-31881 Issues in OTEC commercialization HANDBOOKS Solar energy for buildings handbook [ORO-5362-T1] p0719 A80-44606 Energy choices for the 1980s p0631 N80-28880 p0570 A80-47099
The challenge of financing geothermal development Weld overlaying for corrosion resistance in coal p0727 A80-48317 gasification atmospheres GRAIN BOUNDARIES FR-2621-131 p0711 N80-32726 Theory of polycrystalline silicon solar cells -Effect of reduction in grain boundary HARMODIC ADALYSIS Harmonic analysis of Stirling engine thermodynamics recombination states p0730 A80-48408 p0597 A80-46258 The influence of grain size and dopant Hawaii Geothermal Project 'A' wellhead generator concentration on the electrical properties of feasibility project polycrystalline silicon films p0727 A80-48316 D0600 A80-46696 HRAT CAPACITY MAPPING MISSION Geological and geothermal data use investigations Research on Cu sub x S/(cd, Zn) S photovoltaic solar energy converters for application Explorer mission-A (heat [LBL-10791] p0654 N80-32927 capacity mapping mission)
[180-10279] GRAPHS (CHARTS) p0698 N80-29822 HEAT BICHARGERS Solar energy system economic evaluation for Elcam-Tempe, Tempe, Arizona and Elcam-San Diego, San Diego, California [NASA-CE-161492] p0644 N80-318 Heat exchanger effectiveness for solar collectors p0596 A80-45320 Low-cost, high-efficiency silicon by heat exchanger method and fixed abrasive slicing p0644 N80-31872 GRASSES Production of sugarcane and tropical grasses as a technique --- for solar cells p0600 A80-46700 Experimental investigation of thermal renewable energy source [ORO-5912-T3] D0699 N80-30543 characteristics of solar thermoelement block

p0611 A80-47157

A new method of efficient heat transfer and storage at very high temperatures	Transient response of a latent beat storage unit - An analytical and experimental investigation
p0762 180-48180	[ASME PAPER 79-HT-36] p0761 A80-45726
Air/rock storage for solar central receiver power stations	A model direct contact heat transfer for latent heat energy storage
P0613 A80-48196	p0765 A80-48241
Simulation of mass transfer processes in geothermal power cycles with direct contact heat	Simulation and evaluation of latent heat thermal energy storage heat pump systems
exchange	p0771 A80-48478
p0724 A80-48222 Study of thermal energy storage using fluidized	Active heat exchange system development for latent heat thermal energy storage
bed heat exchangers p0764 180-48240	[NASA-CR-159727] p0775 N80-29857 Energy storage as heat-of-fusion in containerized
Management of a large, operational solar pond	salts. Report on energy storage boiler tank
p0617 180-48363 Baterials considerations for the coupling of	[AD-A087753] p0777 H80-32862 HBAT PIPES
thermochemical hydrogen cycles to tandem mirror reactors	Heat pipes. Citations from the NTIS data base
p0662 A80-48405	[PB80-809940] p0781 N80-28680 Heat pipes. Citations from the NIIS data base
Harmonic analysis of Stirling engine thermodynamics p0730 A80-48408	[PB80-809957] p0781 B80-28681 Heat pipes. Citations from the Engineering Index
Design study of a coal-fired thermionic	data base
/THI/-topped power plant p0730 A80-48422	[PB80-809965] p0781 B80-28682 Heat pipes. Citations from the engineering index
Development of a falling-bed fusion blanket system for synthetic fuel production	data base
p0678 A80-48447	Study on the utilization of solar energy for the
On the selection of working fluids for OTEC power plants	operation of Spacelab material science furnaces [DS-ERT-21-79] p0640 N80-30349
p0738 A80-50946	Analysis of a passive heat pipe cooled solar
The use of refuse heat assisted by heat transformers p0686 A80-51499	photovoltaic receiver [SAND-80-7011] p0651 M80-32885
Thermal energy storage systems using fluidized hed heat exchangers	HEAT PUMPS  Hybrid system consisting of silicon solar cells
[NASA-CR-159868] p0775 N80-28866	with concentrators and heat pump
Active heat exchange system develorment for latent heat thermal energy storage	p0608 A80-46792 Bigh temperature heat pump applications -
[NASA-CE-159727] p0775 N80-29857 Design study of a two-phase turbine bottoming cycle	Conmercial, industrial, and with alternative
[DOE/ET-15350/T1] p0744 N80-30757	energy sources p0670 A80-47590
Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite	Heat pumps in low temperature applications —- using geothermal resources
National Park, California	p0723 A80-48184
[NASA-CR-161539] p0645 M80-31883 Continued evaluation of compact heat exchangers	Sensitivity analysis of the value of a solar driven chemical heat pump system
for OTEC evaluation [COO-4238-14] p0750 M80-31945	p0616 A80-48287 Development status and utility of the sulfuric
RAT PLUX	acid chemical heat pump/chemical energy storage
Heat flux at the thermionic collector p0732 A80-48477	system p0765 A60-48288
The HTGR-GT closed-cycle gas turbine - A plant	Engineering prototype studies on the CaCl2-CH3OH chemical heat pump for solar air conditioning,
concept with inherent cogeneration /power plus	heating, and storage
heat production/ capability p0724 A80-48248	p0616 A80-48289 A thermodynamic analysis of a metal hydride heat
The functional use of the heat generated by a refuse incineration plant as exemplified by the	pump p0661 A80-48290
HIP Hamburg Stapelfeld	Analysis of a heat-activated Stirling heat pump
p0681 A80-49962 Combined production of electrical energy and heat	p0730 180-48424 Development of a diaphragm Stirling engine
in municipal refuse incinerators in the greater Paris area	heat-actuated heat pump
p0682 A80-49965	p0731 180-48425 An energy and cost analysis of residential heat
The potential in Denmark for substituting natural resources by Waste incineration products	pumps in northern climates p0571 A80-48426
p0682 A80-49974 Cogeneration Technology Alternatives Study (CTAS).	Universal thermoelectric design curves of heat
Volume 6: Computer data. Part 1: Coal-fired	pumps
nocogeneration process boiler, section A [NASA-CR-159770-PT-1-A] p0745 N80-30888	Simulation and evaluation of latent heat thermal energy storage heat pump systems
Cogeneration Technology Alternatives Study (CTAS).	P0771 A80-48478
Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section B	Test evaluation of a prototype 18-ton solar powered heating and cooling system
[MASA-CR-159770-FT-1-B] p0745 M80-30889 Cogeneration Technology Alternatives Study (CTAS).	p0619 A80-48480 Twenty years of experience with well-water-source
Volume 6: Computer data. Part 2:	heat pumps at Battelle's Columbus Laboratories
Residual-fired nocogeneration process boiler [BASA-CE-159770-PI-2] p0745 #80-30890	p0733 A80-48481 A design method for parallel solar-heat pump systems
HEAT OF COMBUSTION Waste oil as a fuel	p0621 A80-48922 Thermodynamic and economic analysis of heat pumps
p0684 A80-50032	for energy recovery in industrial processes
HEAT OF DISSOCIATION Automotive storage of hydrogen using modified	[ASME PAPER 78-WA/HT-64] p0686 A80-52049  Heat-pump-centered integrated community energy
magnesium bydrides [SAB-1167-1] p0666 H80-31650	systems: System development summary
HEAT OF PUSICE	Ground coupled solar heat pump research program in
Investigation of nitrate salts for solar latent heat storage	the United States [BHL-27383] p0636 B80-29867
	- · · · · · · · · · · · · · · · · · · ·

p0595 A80-45316

SUBJECT INDEX BEAT STORAGE

Hybrid photovoltaic/thermal systems with a solar-assisted heat pump po642 me0-30919	Thermal energy storage using Glauber's salt - Improved storage capacity with thermal cycling p0764 A80-48197
Sulfuric acid and water chemical heat pump/chemical energy storage program, phase 2-1	Study of thermal energy storage using fluidized bed heat exchangers
[SAND-78-8176] p0776 N80-30924 Development of solar driven absorption air conditioners and heat rumps	p0764 A80-48240 A model direct contact heat transfer for latent heat energy storage
[LBL-10771] Solar assisted heat pump program overview and summary of work at Brookhaven National Laboratory	p0765 A80-48241 Experimental and theoretical studies of thermal energy storage in aquifers
[BNL-27662] p0642 N80-30926 Thermally driven open-cycle heat pump system	p0766 A80~48334 Seasonal thermal energy storage of chilled water
[COMP-800549-1] p0582 M80-30938 Solar assisted heat pump studies: Heat pump hardware and experiments, simulations, Barth	in aquifers p0766 A80-48335 Temperature-induced permeability alterations in
coupling contracts and supporting contracts [BNI-27668] p0647 N80-31933 Heat pumps in low temperature applications	unconsolidated and consolidated aquifer media for seasonal thermal energy storage p0766 A80-48336
[COMP-800806-7] p0711 N80-32699 Annual Cycle Energy System (ACES)	The economics of compressed air energy storage with thermal energy storage
[ORBL/COH-42]  Beconomic evaluation of the Annual Cycle Energy  System (ACES). Volume 1: Executive summary	p0767 A80-48339 Simulation and evaluation of latent heat thermal energy storage heat pump systems
[ORHL/SUB-7470/1-V1] p0587 N80-32905 Peasibility study on a solar house heating system with a low quality thermal flow	p0771 A80-48478  Heat storage capability of a rolling cylinder using Glauber's salt
[EUR-6696-EN] p0655 N80-32939 Self controlling, self pumping heat circulation	p0773 A80-50945 Transient thermal behaviour of solar ponds p0623 A80-50962
system study [COO-4484-07] p0656 N80-32952 HEAT RADIATORS	The development of thermal energy storage systems exploiting solid-solid phase transitions
Heat-rejection design for large concentrating solar arrays p0614 A80-48211	p0774 A80-50970 Thermal energy storage using saturated salt solutions
BEAT BESISTABT ALLOIS  Requirements for materials for land vehicle gas turbines	An investigation of the thermal energy storage capacity of Glauber's salt with respect to
p0743 N80-29345	thermal cycling
Alternatives for heat supply in biomass energy conversion systems p0673 A80-48277	The effect of design parameter changes on the performance of thermal storage wall passive systems
HEAT STORAGE	p0626 A80-52829
A review of collector and energy storage technology for intermediate temperature applications	Transfer function of a sensible-heat storage element in periodic regime p0774 A80-52974
p0595 180-45311 The layer perovskites as thermal energy storage systems	Thermal energy storage systems using fluidized bed heat exchangers [NASA-CR-159868] p0775 N80-28866
p0761 A80~45315 Investigation of nitrate salts for solar latent heat storage	Internally insulated thermal storage system development program [SAND-80-8175] p0775 N80-28924
p0595 A80-45316 Heat loss and storage functions for a thermal well	Active heat exchange system development for latent heat thermal energy storage
p0596 A80~45318 Numerical simulation of dual-media thermal energy storage systems	[NASA-CR-159727] p0775 R80-29857 High temperature thermal energy storage in steel and sand
[ASME PAPER 79-HT-35] Transient response of a latent heat storage unit - An analytical and experimental investigation	[NASA-CR-159708] p0776 N80-29860 Engineering design for Thermocrete central storage units for low temperature solar application
[ASME PAPRE 79-HT-36] p0761 A60-45726 Performance of an inlet manifold for a stratified storage tank	[DOE/CS-34702/4] p0638 N80-29883 Automotive storage of hydrogen using modified magnesium hydrides
[ASME PAPEE 79-HT-67] Sizing procedure and economic optimization methodology for seasonal storage solar systems	[SAN-1167-1]  Small solar electric system components demonstration  thermal storage modules for Brayton systems
A80~46570 Heat storage utilizing Thermol 81 Energy Storage	[NASA-CR-163513] p0644 N80-31875 Thermal energy storage for solar thermal
—- phase change material in polyethylene tube p0762 A80-47598 Transient thermal analysis of phase change thermal	applications program [SAND-80-8218] p0646 N80-31918 Thermal energy storage for building heating and
energy storage systems [ASME PAPER 80-H1-2] Performance of storage walls with highly	cooling applications [ORBL/TH-7319] Annual Cycle Energy System (ACES)
conductive covering plates and connecting fins [ASME PAPER 80-HT-18] p0762 A80-48009 A new method of efficient heat transfer and	[ORNL/CON-42] p0587 N80-32880 Seasonal thermal energy storage [PNL-3322] p0778 N80-32899
storage at very high temperatures p0762 180-48180	Investigation of the feasibility of using wind power for space heating in colder climates
Energy conservation and environmental benefits of thermal energy storage systems in the pulp and paper industry	[DOE/DP-03533/T3] p0753 N80-32950 Self controlling, self pumping heat circulation system study
p0763 A80-48194 Air/rock storage for solar central receiver power stations	[COO-4484-07] p0656 N80-32952 Model of direct contact heat transfer for latent heat energy storage
p0613 A80-48196	[SERI/TP-631-567] p0779 N80-32955 Design package for solar domestic hot water system [NASA-CR-161558] p0657 N80-33867

BEAT TRANSPER SUBJECT INDEX

TOLE BOLKARIO	
Triangly cooled cabled superconductors I	Solar passive systems for buildings
Internally cooled cabled superconductors. I for applications to fusion reactors and MHD	[PB80-187719] p0656 B80-32962 Pseudo-shock as a qualitative model in the
generators	investigation of the influence of wall roughness
p0720 A80-45054	on the performance of supersonic MHD generators
Heat loss and storage functions for a thermal well	[AD-A088333] p0754 880-33228
p0596 A80-45318	Modeling of heat and mass transfer during coal
Evaluation of wall temperature difference profiles	block gasification
for heat absorption tubes exposed nonuniformly	p0713 #80-33577
to solar radiation	BEAT TRANSMISSION
p0596 A80-45319	Self controlling, self pumping heat circulation
Calculation of heat-transport-medium flow rate in	System study 5000-0000 50656 800-22052
heat receivers of passive solar-heating systems p0611 A80-47159	[COO-4484-07] p0656_B80-32952 BRAT TREATMENT
Study of the insulating wall boundary layer in a	Processing of coal, oil sand and heavy oil in situ
Faraday BED generator	by electric and magnetic fields
p0722 A80-47763	p0669 A80-44846
Transient thermal analysis of phase change thermal	A sultiple p-n junction structure obtained from
energy storage systems	as-grown Czochralski silicon crystals by heat
[LSHE PAPER 80-HT-2] p0762 A80-48001	treatment - Application to solar cells
Performance of storage walls with highly	p0595 A80-45121
conductive covering plates and connecting fins	Status report on the research programme 'New
[ASBE PAPER 80-BI-18] p0762 A80-48009 Theoretical study of absorbed solar energy in	processes of thermal waste treatment <sup>1</sup> . p0680 A80-49937
multi-layer absorber coatings for receivers of	HEATRES .
solar concentrators. II - Heat transfer analysis	Development of the high temperature air heater for
[ASHE PAPER 80-HT-105] p0612 A80-48034	open cycle MBD
Heat transfer as a diagnostic tool in the	p0724 A80-48224
development of direct coal-fired MHD combustors	An algorithm for the preliminary design of
[ASHE PAPER 80-HT-125] p0722 A80-48040	Stirling engine heaters
A new method of efficient heat transfer and	p0730 A80-48411
storage at very high temperatures	BBATING
A model direct contact heat transfer for latent	An improved synthesis of 2,4,8,10-tetroxaspiro (5.5) undecane
heat energy storage	[BASA-CASE-ARC-11243-2] p0583 N80-31472
p0765 A80-48241	Pulse combustion technology for heating applications
High-temperature gas-cooled reactors and process	[ANL/RES/TH-85] p0707 N80-32467
heat	Stack gas reheat evaluation
p0758 A80-48312	[FB80-196850] p0593 N80-33980
Design of the HTGR for process heat applications	HEATING EQUIPMENT
p0758 A80-48313	Calculation of heat-transport-medium flow rate in
An investigation of simultaneous heat and mass transfer in subbituminous coal hot gas	heat receivers of passive solar-heating systems
drying for underground coal conversion	p0611 A80-47159 Heat transfer in slurry preheaters for coal
p0676 A80-48344	liquefaction plants
Performance loss due to transient heat transfer in	p0678 A80-48432
the cylinders of Stirling engines	Similarity theory of solar water heater with
p0730 A80-48410	natural circulation
Heat transfer in slurry preheaters for coal	p0621 A80-48917
liquefaction plants	High temperature solar energy conversion systems
p0678 A80-48432 Process economics and the second law in	p0621 A80-48924 A refuse incineration plant in combination with
thermochemical hydrogen production - The effect	district heating demonstrated by the Iserlohn
of heat transfer	Plant
p0663 A80-48459	p0681 A80-49964
On the selection of working fluids for OTEC power	National Passive Solar Conference, 3rd, San Jose,
plants	Calif., January 11-13, 1979, Proceedings
P. p0738 180-50946	p0626 A80-52826
The use of refuse heat assisted by heat transformers	Experimental investigation of the Trombe wall
p0686 A80-51499 Thermoelectric MHD with walls parallel to the	passive solar energy system p0627 A80-52833
nagnetic field	A classification scheme for the common passive and
p0739 A80-52971	hybrid heating and cooling systems
Transfer function of a sensible-heat storage	p0627 A80-52835
element in periodic regime	Heat pipes. Citations from the HTIS data base
p0774 A80-52974	[FB80-809940] p0781 H80-28680
Beat transfer - San Diego 1979; Proceedings of the	Solar energy system performance evaluation.
Bighteenth Mational Conference, San Diego, Calif., August 5-8, 1979	Seasonal report for SEECO Lincoln, Lincoln, Hebraska
p0781 A80-53568	[BASA-CR-161495] p0635 B80-29851
Analysis of the Omnium G receiver	Engineering test facility conceptual design
[SEBI/TE-631-387] p0637 N80-29872	for magnetohydrodynamic generators
Thermally driven open-cycle heat pump system	[DOE/FE-2614/3] p0753 N80-32943
[CONF-800549-1] p0582 N80-30938	BEAVY TONS
Modeling and evaluation of designs for solid	Systems assessment of heavy ion beam fusion drivers
hydrogen storage beds [CONP-800616-8] p0666 N80-32554	[DOE/DP-40039] p0754 980-33247
[CONP-800616-8] p0666 M80-32554 Bnergy storage as heat-of-fusion in containerized	HEAVY Water as a valuable by-product of
salts. Report on energy storage boiler tank	Heavy water as a valuable by-product of electrolytic hydrogen
[AD-A087753] p0777 #80-32862	p0661 A80-47665
Pluid temperature control for parabolic trough	BRLICAL WINDINGS
solar collectors	Form factor for certain types of toroidal solenoids
[SAND-79-2006C] p0652 H80-32894	in tokamak fusion devices .
Analytical prediction of the performance of an air	p0721 A80-47230
photovoltaic/thermal flat plate collector	HELIOSTATS  Constal formula for the insidence factor of a
[DOB/ET-20279/93] p0653 H80-32914 Model of direct contact heat transfer for latent	General formula for the incidence factor of a
heat energy storage	solar heliostat receiver system p0622 A80-49758
[SERI/TP-631-567] p0779 R80-32955	POOE TOO 43130
- · · · · · · · · · · · · · · · · · · ·	

SUBJECT INDEX HYBRID PROPULSION

·	•
HELIUM	HIGH TEMPERATURE BEVIRONMENTS
Closed-cycle helium gas turbine for solar tower	Materials for coal conversion and use. Volume 2:
power plant [ONERA, TP NO. 1980-28] p0597 A80-46228	Materials of construction for coal conversion systems. Part 1: Coal gasification. Part 2:
Thermodynamic analysis of the helium cycles of gas turbine nuclear power plants	Coal liguefaction [PE-2468-59-VOL-2-PT-1/2] p0705 N80-31644
p0721 A80-47080	Optimal thermionic energy conversion with
Helium-topping/organic bottoming - Advanced power	established electrodes for high-temperature
generation system Exergetic/energetic analysis p0673 A80-48247	topping and process heating coal combustion product environments
HELIUM PLASMA	[NASA-TH-81555] p0754 N80-33221
Parametric decay into ion cyclotron waves and drift waves in multi-ion species plasma	HIGH TEMPERATURE GAS COOLED REACTORS  The HTGR-GT closed-cycle gas turbine - A plant
p0735 A80-49071	concept with inherent cogeneration /power plus
BETEROJUECTION DEVICES	heat production/ capability
Selenium heterostructure solar cells p0598 180-46259	p0724 180-48248 High-temperature gas-cooled reactors and process
Evaluation of multijunction structures using	heat
amorphous Si-Ge alloys for solar cells p0602 A80-46719	p0758 180-48312 Design of the HTGR for process heat applications
BBIC and capacitance measurements on Cu2S-CdS	p0758 A80-48313
solar cells - Stability problems Electron Beam Induced Current	HIGH TEMPERATURE GASES
p0603 A80-46725	A new method of efficient heat transfer and storage at very high temperatures
Optimal material properties for CdS/Cu2S solar cells	p0762 A80-48180
p0603 A80-46726 Oxide/semiconductor photovoltaic heterojunctions	Design and operation of fluidised bed industrial boilers and hot gas producers
based on CdTe or InP	p0672 A80-48202
p0603 A80-46732	HIGH TEMPERATURE NUCLEAR REACTORS
Concentration and temperature performances of GaAs-GaAlAs solar cells	Status of nuclear high temperature process heat development in the Federal Republic of Germany
p0603 A80-46734	/coal gasification and long distance energy
Survey of semiconductor combinations for optimum heterojunction thin film solar cells	transport/ p0758 A80-48311
p0605 A80-46753	RIGH TEMPERATURE PLASMAS
Preparation and analysis of Cu2O thin-film solar cells	HIPIRE - Pusion-high temperature electrolysis system p0731 A80-48448
p0607 A80-46781	HIGH TEMPERATURE RESEARCH
Accurate computer analysis of solar cells	Chemical and physical stability of refractories
<pre>including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure</pre>	for use in coal gasification [COO-2904-15] p0690 N80-28478
p0607 A80-46782	HIGH THEPRRATURE TESTS
Investigation of high-voltage heterophotoconverters p0611 A80-47163	Investigation of the service life of aluminum mirrors on metal substrates at high temperatures
n-CdS/p-Si heterojunction solar cells	p0611 A80-47158
p0626 A80-52498	Metallurgical analysis and high temperature degradation of the black chrome selective absorber
Thin film cuprous sulphide-cadmium sulphide solar cells	[LBL-10293] p0643 N80-31538
p0628 A80-52862	HIGH VOLTAGES
HEXENES  Design of a cost effective solar powered water pump	Investigation of high-voltage heterophotoconverters p0611 A80-47163
[PB80-182819] p0649 N80-31967	The planar multijunction cell - A new solar cell
HIGH ACCREBATION Hagnetic-pressure acceleration of cylindrical	for earth and space p0613 A80-48205
liners by the pulse generators for relativistic	A new rechargeable high voltage low temperature
electron beams	molten salt cell p0764 A80-48237
MIGH ENERGY ELECTRONS	High voltage power systems for military needs
Theoretical multiple beam overlap from channel	solar energy conversion equipment
transport of intense particle beams p0735 A80-49067	P0725 A80-48254 HOMOPOLAR GENERATORS
HIGH POWER LASERS	A study of the applicability/compatibility of
Solaser power solar energy lasing in space p0622 A80-50627	inertial energy storage systems to future space missions
Laser technology: Development and applications	[NASA-CR-163584] p0777 880-32856
[GPC-59-826] p0781 N80-29694	HORIZOHTAL ORIENTATION  Possibility studies of speiler and aileren control
BIGH TEMPERATURE Development of a high temperature solid	Peasibility studies of spoiler and aileron control systems for large horizontal-axis wind turbines
electrolyte fuel cell	p0727 A80-48318
p0726 A80-48281 High-temperature water electrolysis for hydrogem	HORSEPOWER Design and development of Stirling engines for
production	stationary power generation applications in the
p0662 A80-48414 High temperature solar energy conversion systems	500 to 3000 horsepower range [DOB/ET-15207/T1] p0752 N80-32723
p0621 A80-48924	HUMAN FACTORS RUGINERRING
Evaluation of high temperature LiAl/TiS2 cells	Health requirements for advanced coal extraction
p0773 A80-50508 High temperature thermal energy storage in steel	systems [NASA-CR-163625] p0714 N80-34093
and sand	HUMAN BRACTIONS
[NASA-CE-159708] p0776 M80-29860 Autoignition characteristics of aircraft-type fuels	Some questions and answers about the Satellite Power System (SPS)
[NASA-CB-159886] p0698 N80-30535	[NASL-CR-163329] p0639 N80-29897
HIGH TEMPERATURE AIR Development of the high temperature air heater for	HYBRID PROPULSION  Trade-off results and preliminary designs of
open cycle BBD	Bear-Term Hybrid Vehicles
p0724 A80-48224	[SAR PAFRE 800064] p0772 A80-49723
Engineering test facility conceptual design for magnetohydrodynamic generators	•
[DOB/PB-2614/3] p0753 N80-32943	

HYDRAULIC EQUIPMENT	Pipeline gas from coal: Hydrogenation (IGT
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation	hydrogasification process) [PB-2434-331] p0703 880-31630
reports	[PB-2434-33A] p0703 N80-31630 Pollutants from synthetic fuels production: Coal
[SAH-1731-T2] p0577 H80-28856	gasification screening test results
Structure of amorphous silicon and silicon hydrides	[PB80-182769] p0707 B80-31986 Hethanol and methyl fuel catalyst
p0599 A80-46647	[FE-3177-5] p0708 B80-32472
Hydrogen storage: Hydrogen as a hydride.	Study of methane fuel for subsonic transport
Citations from the NTIS data base [PB80-811094] p0665 N80-30561	aircraft [NASA-CB-159320] p0708 #80-32533
HYDROCARBON COMBUSTION .,	Alcohol fuels. Citations from the Engineering
Combustion studies of coal-in-oil droplets	Index data base
[DOE/ET-10660/1] p0702 H80-31499 HIDROCARBON FUEL PRODUCTION	[FB80-812449] p0711 N80-32581 Alcohol fuels. Citations from the Engineering
The U.S. coal gasification program - Progress and	Index data base
projects	[£880-812456] p0711 880-32582
p0670 A80-46325 Kelp processing and biomethanation technology	Soot reduction in diesel engines by catalytic
p0673 A80-48278	effects [BBL-27792] p0585 B80-32731
. The HIGAS process to produce pipeline gas from coal	HYDROCARBONS .
p0674 A80-48291 The CS/B advanced SBG hydrogasification process	Solar energy utilization by carbanion photolysis p0625 A80-51680
p0674 A80-48292	Effect of operating conditions on production of
Indirect liquefaction via the Avco coal	light hydrocarbon gases in slagging fixed-bed
gasification system p0674 180-48296	coal gasification [GPBTC/BI-80/2] p0695 M80-29507
Chem Systems' liquid phase methanol process	Effects of gasohol on idle HC and CO emissions
p0677 A80-48383	[PB80-190655] p0590 N80-33018
Mobil methanol-to-gasoline process p0677 180-48384	HYDROCRACKING
Liquid products from peat pyrolysis	Development of unique catalysts for hydrodenitrogenation of coal-derived liquids
p0677 A80-48385	anilines
The flash hydropyrolysis of lignite and sub-bituminous coals to both liquid and gaseous	[FE-3297-2] p0690 M80-28545 Development of unique catalysts for
hydrocarbon products	hydrodenitrogenation of coal-derived liquids
p0679 180-49626	decabydroquinoline and quinoline
Production of light aromatics from coal hydrogenates	[PE-3297-3] p0690 N80-28546
p0680 A80-49631 The production of substitute natural gas and	Development of new catalysts for coal liquids refining
recyclables from municifal solid waste	[FE-2595] p0691 N80-28553
p0683 A80-49996 Biogasification of municipal waste	Refining and upgrading of synfuels from coal and
p0683 A80-49997	oil shales by advanced catalytic processes. Laboratory and pilot plant studies of the
Use of gas from landfills for energy recovery -	processing of SRC-1
Operating experience at Palos Verdes p0683 180-49999	[PE-2315-45] p0699 H80-30544 Upgrading of coal liquids: Hydrocracking of EDS
Methane production from urban solid wastes	process derived gas oils
p0683 A80-50000	[FE-2566-33] p0699 N80-30545
Thermodynamic analysis of coal gasification processes	Pittsburgh Energy Technology Center bydrogasification process: Conceptual
p0686 A80-51210	commercial scale plant design
The technical and economic aspects of brown coal refinement	[DOB/MC-08464/T1] p0703 N80-31633
p0686 A80-51498	<pre>Advanced development of a short-residence-time   hydrogasifier</pre>
Biomass - Puture developments	[PE-3125-12] p0704 880-31638
p0687 A80-52858 The hydropyrolysis of coal to BTX Benzene,	<pre>Advanced development of a short-residence-time     hydrogasifier</pre>
Toluene and Tylenes	[FE-3125-18] p0704 #80-31639
p0688 A80-53174	Research and development of an advanced process
Methane formation during hydrogen gasification and	for conversion of coal to synthetic gasoline and
gas phase pyrolysis of selected aromatics p0689 A80-54034	other distillate motor fuels [FE-1800-45] p0704 #80-31641
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion	other distillate motor fuels [FE-1800-45] p0704 880-31641 BYDRODYHAMICS
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BBL-51117]	other distillate motor fuels [FE-1800-45] p0704 B80-31641 BYDRODYHAMICS Wave drift forces on OTEC platforms
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion	other distillate motor fuels [FE-1800-45] p0704 880-31641 BYDRODYHAMICS
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BBL-51117] p0692 N80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 N80-31646	other distillate motor fuels [PE-1800-45] p0704 B80-31641 BYDRODYBANICS Save drift forces on OTEC platforms p0740 A80-53676 BYDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BRL-51117] p0692 R80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 R80-31646 Economic evaluation of the MIT process for	other distillate motor fuels [F2-1800-45] p0704 880-31641  BYDRODYNAMICS Tave drift forces on OTEC platforms p0740 A80-53676  BYDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BBL-51117] p0692 N80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 N80-31646	other distillate motor fuels [PE-1800-45] p0704 B80-31641 BYDRODYBANICS Save drift forces on OTEC platforms p0740 A80-53676 BYDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BBL-51117] p0692 R80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 R80-31646 Bconomic evaluation of the HIT process for manufacture of ethanol [DSE-3992-T1] p0705 R80-31647 Liquid fuels production from biomass corn and	other distillate motor fuels [FE-1800-45] p0704 880-31641  BYDRODYNAMICS Nave drift forces on OTEC platforms p0740 A80-53676  BYDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126  Study of a hydro-photovoltaic plant for peak power generation in central and northern European
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BRL-51117] p0692 N80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 N80-31646 Economic evaluation of the MIT process for manufacture of ethanol [DSE-3992-T1] p0705 N80-31647 Liquid fuels production from biomass corn and algae	other distillate motor fuels [PE-1800-45] p0704 880-31641 BYDRODINAMICS Nave drift forces on OTEC platforms  BYDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic power generator, which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BBL-51117] p0692 R80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 R80-31646 Bconomic evaluation of the HIT process for manufacture of ethanol [DSE-3992-T1] p0705 R80-31647 Liquid fuels production from biomass corn and	other distillate motor fuels [FE-1800-45] p0704 880-31641  BIDRODINAMICS  Wave drift forces on OTEC platforms  p0740 A80-53676  BYDROBLECTRIC POWER STATIONS  Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126  Study of a hydro-photovoltaic plant for peak power generation in central and northern European
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BNI-51117] p0692 N80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBI-9789] p0705 N80-31646 Bconomic evaluation of the MIT process for manufacture of ethanol [DSE-3992-T1] p0705 N80-31647 Liquid fuels production from biomass corn and algae [COO-4388-10] p0708 N80-32545 Assessment of Peruvian biofuel resources and alternatives	other distillate motor fuels [PE-1800-45] p0704 880-31641 BYDRODINAMICS Stave drift forces on OTEC platforms  BYDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic power generator, which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries  Performance and applications potential of a turbine-pump with controlled flow rate for
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BNL-51117] p0692 N80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 N80-31646 Bconomic evaluation of the HIT process for manufacture of ethanol [DSR-3992-T1] p0705 N80-31647 Liquid fuels production from biomass corn and algae [COO-4388-10] p0708 N80-32545 Assessment of Peruvian biofuel resources and alternatives [AHL/BES/TH-86] p0708 N80-32547	other distillate motor fuels [PE-1800-45] p0704 880-31641 BIDRODISANICS Save drift forces on OTEC platforms p0740 A80-53676 BIDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic power generator, which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries p0605 A80-46746 Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BNI-51117] p0692 N80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBI-9789] p0705 N80-31646 Bconomic evaluation of the MIT process for manufacture of ethanol [DSE-3992-T1] p0705 N80-31647 Liquid fuels production from biomass corn and algae [COO-4388-10] p0708 N80-32545 Assessment of Peruvian biofuel resources and alternatives	other distillate motor fuels [PE-1800-45] p0704 880-31641 BIDRODINAMICS Stave drift forces on OTEC platforms  BIDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic power generator, which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries  Performance and applications potential of a turbine-punp with controlled flow rate for
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BNL-51117] p0692 H80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 H80-31646 BCONOMIC evaluation of the HIT process for manufacture of ethanol [DSE-3992-T1] p0705 H80-31647 Liquid fuels production from biomass corn and algae [CO0-4388-10] p0708 H80-32545 Assessment of Peruvian biofuel resources and alternatives [AHL/EES/TH-86] p0708 H80-32547 HYDROCARBOB FUELS Comparative analysis of the basic combustion characteristics of some heavy hydrocarbon fuels	other distillate motor fuels [PE-1800-45] p0704 880-31641 BYDRODYNAMICS Save drift forces on OTEC platforms  P0740 A80-53676 BYDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries  P0605 A80-46746 Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  P0768 A80-48375 Potential for hydropower development at existing dams in New England Volume 1: Physical and
gas phase pyrolysis of selected aromatics	other distillate motor fuels [PE-1800-45] p0704 880-31641  BYDRODYHAMICS Save drift forces on OTEC platforms p0740 A80-53676  BYDROBLECTRIC POWER STATIONS  Estimated performance of an electrohydrodynamic power generator, which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126  Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries  p0605 A80-46746  Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage p0768 A80-48375  Potential for hydropower development at existing dams in New England Volume 1: Physical and economic findings and methodology
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BNL-51117] p0692 H80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 H80-31646 Bconomic evaluation of the HIT process for manufacture of ethanol [DSE-3992-T1] p0705 H80-31647 Liquid fuels production from biomass corn and algae [CO0-4388-10] p0708 H80-32545 Assessment of Peruvian biofuel resources and alternatives [AHL/EBS/TH-86] p0708 H80-32547 HYDROCARBOB FUELS Comparative analysis of the basic combustion characteristics of some heavy hydrocarbon fuels in application to aircraft gas turbine engines p0721 A80-47424 Investigation of the feasibility of methanol as an	other distillate motor fuels [PE-1800-45] p0704 880-31641 BYDRODYNAMICS Save drift forces on OTEC platforms  P0740 A80-53676 BYDROBLECTRIC POWER STATIONS Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries  P0605 A80-46746 Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  P0768 A80-48375 Potential for hydropower development at existing dams in New England Volume 1: Physical and
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BNL-51117] p0692 N80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 N80-31646 Bconomic evaluation of the MIT process for manufacture of ethanol [DSE-3992-T1] p0705 N80-31647 Liquid fuels production from biomass corn and algae [COO-4388-10] p0708 N80-32545 Assessment of Peruvian biofuel resources and alternatives [ANL/RES/TM-86] p0708 N80-32547 HIDROCARBON FUELS  Comparative analysis of the basic combustion characteristics of some heavy hydrocarbon fuels in application to aircraft gas turbine engines p0721 N80-47424 Investigation of the feasibility of methanol as an automobile fuel	other distillate motor fuels [PE-1800-45] p0704 B80-31641 BYDRODYHAMICS Stave drift forces on OTEC platforms  p0740 A80-53676 BYDROBLECTRIC POWER STATIONS  Estimated performance of an electrohydrodynamic power generator, which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries  p0605 A80-46746 Performance and applications potential of a turbine-punp with controlled flow rate for solar and windpower energy storage  p0768 A80-48375 Potential for hydropower development at existing dams in New England Volume 1: Physical and economic findings and methodology [PB80-169121] Potential for hydropower development at existing dams in New England. Volume 2: User's manual
gas phase pyrolysis of selected aromatics p0689 180-54034 Alternative process schemes for coal conversion [BNI-51117] p0692 180-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBI-9789] p0705 180-31646 Economic evaluation of the MIT process for manufacture of ethanol [DSE-3992-T1] p0705 180-31647 Liquid fuels production from biomass corn and algae [C00-4388-10] p0708 180-32545 Assessment of Peruvian biofuel resources and alternatives [ANL/RES/TM-86] p0708 180-32547 HYDROCARBOB FUELS Comparative analysis of the basic combustion characteristics of some heavy hydrocarbon fuels in application to aircraft gas turbine engines p0721 180-47424 Investigation of the feasibility of methanol as an automobile fuel	other distillate motor fuels [PE-1800-45] p0704 880-31641  BYDRODYNAMICS  Nave drift forces on OTEC platforms  BYDROBLECTRIC POWER STATIONS  Estimated performance of an electrohydrodynamic power generator, which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126  Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries  p0605 A80-46746  Performance and applications potential of a turbine-punp with controlled flow rate for solar and windpower energy storage  p0768 A80-48375  Potential for hydropower development at existing dams in New England Volume 1: Physical and economic findings and methodology [PB80-169121] p0578 880-28934  Potential for hydropower development at existing dams in New England. Volume 2: User's manual [PB80-169139]
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BNL-51117] p0692 N80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 N80-31646 Economic evaluation of the HIT process for manufacture of ethanol [DSE-3992-T1] p0705 N80-31647 Liquid fuels production from biomass corn and algae [COO-4388-10] p0708 N80-32545 Assessment of Peruvian biofuel resources and alternatives [AHL/EBS/TH-86] p0708 N80-32547 HYDROCARBOB FUELS Comparative analysis of the basic combustion characteristics of some heavy hydrocarbon fuels in application to aircraft gas turbine engines p0721 N80-47424 Investigation of the feasibility of methanol as an automobile fuel p0688 N80-52881 Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from	other distillate motor fuels [PE-1800-45] p0704 B80-31641 BYDRODYHAMICS Stave drift forces on OTEC platforms  p0740 A80-53676 BYDROBLECTRIC POWER STATIONS  Estimated performance of an electrohydrodynamic power generator, which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126 Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries  p0605 A80-46746 Performance and applications potential of a turbine-punp with controlled flow rate for solar and windpower energy storage  p0768 A80-48375 Potential for hydropower development at existing dams in New England Volume 1: Physical and economic findings and methodology [PB80-169121] Potential for hydropower development at existing dams in New England. Volume 2: User's manual
gas phase pyrolysis of selected aromatics p0689 A80-54034 Alternative process schemes for coal conversion [BNL-51117] p0692 H80-28560 Liquid fuels from biomass: Catalysts and reaction conditions [LBL-9789] p0705 H80-31646 Bconomic evaluation of the HIT process for manufacture of ethanol [DSE-3992-T1] p0705 H80-31647 Liquid fuels production from biomass corn and algae [CO0-4388-10] p0708 H80-32545 Assessment of Peruvian biofuel resources and alternatives [AHL/BES/TH-86] p0708 H80-32547 HYDROCARBOB FUELS Comparative analysis of the basic combustion characteristics of some heavy hydrocarbon fuels in application to aircraft gas turbine engines p0721 A80-47424 Investigation of the feasibility of methanol as an automobile fuel p0688 A80-52881 Investigation of sulfur-tolerant catalysts for	other distillate motor fuels [PE-1800-45] p0704 880-31641  BYDRODYNAMICS  Nave drift forces on OTEC platforms  P0740 A80-53676  BYDROBLECTRIC POWER STATIONS  Estimated performance of an electrohydrodynamic power generator, which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717, A80-44126  Study of a hydro-photovoltaic plant for peak power generation in central and northern European countries  P0605 A80-46746  Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  P0768 A80-48375  Potential for hydropower development at existing dams in New England Volume 1: Physical and economic findings and methodology [PB80-169121]  Potential for hydropower development at existing dams in New England. Volume 2: User's manual [PB80-169139]  Bydrogen production from remote power sites

SUBJECT THREE HYDROGRE PRODUCTION

Proceedings of the Clemson Workshop on Environmental Impacts of Pumped Storage Hydroelectric Operations electrolytic hydrogen [PB80-192453] DOSAR NAO-32964 HYDROBLECTRICITY Evaluation of hydropower potential in a river basin
--- Prediction analysis technique Energy programs at the Johns Hopkins University
Applied Physics Laboratory
[B80-195316] HYDROGRE Tandem Birror Reactor Hydrogen distribution and transfer in coal hydrogenation systems p0758 N80-29473 [DOE/PC-30014/1] Bydrogen storage: Hydrogen as a hydride. Citations from the BTIS data base [PB80-811094] p0665 N80-30561 Materials for fuel cells [PB80-182355] p0748 #80-30955 reactors Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 #80-31650 Solar energy conversion through biophotolysis
[SAN-0034-239-1-T2] p0666 N80-31927 Electrolysis-based hydrogen storage technology p0647 N80-31928 [BNL-26923] Catalyst characterization in coal liquefaction [SAND-80-0123] p0709 N80-3 Investigation of mechanisms of hydrogen transfer p0709 N80-32560 in coal hydrogenation, phase 2
[PE-2305-30] p0710 N80-32568
Assessment of hydrogen compressor technology for production energy storage and transmission systems [ORO-5598-T1] p066 cadmium cycle P0667 N80-32922 HYDROGEN ENGINES Hydrogen engine performance analysis project [SAN-1212-T1] p0665 N80-30756 Study of hydrogen-powered versus battery-powered automobiles [ATR-79 (7759)-1-VOL-1] p0665 880-31271 HYDROGEN PURLS Experiments on H2-O2 MHD power generation fuel plant P0717 A80-44239 Conversion of carbohydrate into hydrogen fuel by a photocatalytic process p0661 A80-44598 Catalytic combustion of hydrogen in model appliances p0662 A80-48415 Gas distribution equipment in hydrogen service of heat transfer p0758 A80-48506 Prospects for hydrogen aircraft .
[SAE PAPER 800756] p0664 A86
Automotive storage of hydrogen using modified P0664 180-49704 magnesium bydrides [SAH-1167-1] Hydrogen use as a fuel. Citations from the NTIS data base (PB80-8130901 D0667 N80-33607 BYDROGEN OXYGEN ENGINES Experiments on H2-O2 MHD power generation P0717 A80-44239 HYDROGEN CITGEN FURL CELLS Improved alkaline hydrogen/air fuel cells for synthetic catalysts transportation applications p0726 A80-48282
The influence of contact pressure on the
performance of supported gas diffusion
electrodes in alkaline H2-02-fuel cells p0739 A80-51459
Development of a 7 kW H2/02-fuel cell assembly with circulating electrolyte in a compact modular design p0739 A80-51692 Materials for fuel cells [PB80-182355] p0748 N80-30955 HYDROGRN PRODUCTION production Bydrogen in metals - Outstanding properties and examples for utilization. II p0661 A80-43842 Conversion of carbohydrate into hydrogen fuel by photocatalytic process p0661 180-44598
Hydrogen and oxygen from water. III - Evaluation frame [ NASA-CR-163392] of a hybrid process p0661 A80-45298 base

Heavy water as a valuable by-product of p0661 A80-47665 Utilization of solar radiation for water photolysis p0661 A80-47667 Projected costs for electricity and products from OTEC facilities and plantships p0728 .A80-48349 Perspective on the DOE fusion synthetic fuels p0677 A80-48402 The fusion-synfuel tie producing hydrogen with the p0662 A80-48403 Interfacing the Tandem Mirror Reactor to the sultur-iodine process for hydrogen production p0662 180-48404

Haterials considerations for the coupling of thermochemical hydrogen cycles to tandem mirror p0662 180-48405 Scoping study of a tandem-mirror fusion reactor coupled to a thermochemical hydrogen synfuel plant p0662 A80-48406 The MARK-13 process for hydrogen production p0662 A80~48412 Development status of the General Electric solid polymer electrolyte water electrolysis technology p0662 A80-48413 High-temperature water electrolysis for hydrogen p0662 A80~48414 Hydrogen production from the solar based LASL p0662 A80-48416 High-temperature thermochemical water splitting cycle fusion reactor design considerations p0663 A80-48449
Present and future status of thermochemical cycles applied to fusion energy sources p0663 A80-48450 Bigh-temperature fusion blanket for a synthetic p0663 A80-48451 A comparison of capital cost estimates and process efficiencies for hydrogen production by thermochemical cycles and water electrolysis p0663 A80-48458 Process economics and the second law in thermochemical hydrogen production - The effect p0663 A80-48459 Recent progress on the sulfur cycle hybrid hydrogen production process p0663 A80-48460 Off-peak power for hydrogen production P0663 A80-48461 A hybrid water-splitting cycle using copper sulfate and mixed copper oxides p0664 A80-48503 A theoretical study of the modelling and control of a solar water electrolysis plant p0621 A80-48919 Biophotolytic H2 production using alginate-immobilized chloroplasts, enzymes and p0664 A80-50247 The thermodynamics of aqueous water electrolysis p0664 A80-50511 Models for the photoelectrolytic decomposition of water at semiconducting oxide anodes p0664 A80-50512 Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460 A study on utilizing solar energy for hydrogen p0665 A80-53569 Methane formation during hydrogen gasification and gas phase pyrolysis of selected aromatics D0689 A80-54034 Solar/hydrogen systems assessment. Volume 1: Solar/hydrogen systems for the 1985 - 2000 time p0665 N80-28865 Hydrogen production. Citations from the NTIS data

[PB80-810476]

p0665 N80-29519

	•
Simultaneous photoproduction of hydrogen and	LC-Fining of solvent refined coal - SEC-I and
oxygen by photosynthesis to convert solar	short contact time coal extracts Lummus
energy into stored chemical free energy	Cities Fining catalytic hydrogenation process
[CONF-791072-32] p0665 #80-30550	p0678 A80-4843
Hydrogen storage: Hydrogen as a hydride.	Reaction modelling and correlation for flash
Citations from the NTIS data base	hydropyrolysis of lignite
[PB80-811094] p0665 N80-30561	p0678 A80-4843
A study of industrial hydrogen and syngas supply	Catalytic hydrogenation of Liddell bituminous coal
systems	- Effects of process variables on coal
[NASA-CR-163523] p0666 N80-31624	dissolution in batch autoclaves
Hydrogen production by the GA sulfur-iodine process	p0679 180-4962
[GA-A-15777-REV] p0666 H80-31651 Hydrogen production from remote power sites	Qualitative and quantitative assessment of
[BHL-27457] p0666 M80-32553	reaction models of coal hydrogenation p0679 A80-4962
Modeling and evaluation of designs for solid	Selectivity improvement in the solvent refined
hydrogen storage beds	coal process. I - Detailed first-stage reaction
[CONF-800616-8] p0666 N80-32554	studies - Coal mineral catalysis. II - Detailed
Pusion reactors for hydrogen production via	second-stage reaction studies - Hydrotreating of
electrolysis	coal liquids
[BNL-27782] p0667 N80-32559	p0679 180-4963
Hydrogen production by photoelectrolytic	Production of light aromatics from coal hydrogenate
decomposition of H2O using solar energy	p0680 A80-4963
[HASA-CR-163586] p0667 H80-32854	Kinetics and mechanisms of catalytic
Pusion: An energy source for synthetic fuels	hydroliquefaction and hydrogasification of lignit
[BNL-27891] p0667 N80-33205 Hydrogen use as a fuel. Citations from the NTIS	[FE-2702-8] p0691 R80-2855
data base	Hydrogen distribution and transfer in coal hydrogenation systems
[PB80-813090] p0667 N80-33607	[DOE/PC-30014/1] p0758 H80-2947
EYDROGES RECOMBINATIONS	Catalyst development for coal liquefaction
Hydrogen storage: Hydrogen as a hydride.	[EPRI-AP-1233] p0696 880-2950
Citations from the BTIS data base	Investigation of mechanisms of hydrogen transfer
[PB80-811094] p0665 #80-30561	in coal hydrogenation
ETDROGEN SULPIDE	[FE-2305-33] p0697 M80-2951
Shift conversion and methanation in coal	Partial liquefaction of coal by direct hydrogenation
gasification: Bench-scale evaluation of a	[FE-2044-51] p0699 M80-3054
sulfur resistant catalyst	Pipeline gas from coal: Hydrogenation (IGT
[PE-3240-T5] p0696 B80-29509 Assessment of H2s control technologies for	hydrogasification process) [PB-2434-33A] p0703 B80-3163
geothermal power plants	Pipeline gas from coal: Hydrogenation (IGT
[PB80-193709] p0593 #80-33973	hydrogasification process)
HYDROGEE-BASED BEERGY	[FE-2434-58] p0704 M80-3163
Hydrogen in metals - Outstanding properties and	Investigation of mechanisms of hydrogen transfer
examples for utilization. II	in coal hydrogenation, phase 2
p0661 A80-43842	[FE-2305-30] p0710 N80-3256
Hydrogen storage in a beryllium substituted TiPe	HYDROGREOLISIS
compound	Average chemical structure of mild hydrogenolysis
p0661 A80-45060	products of coals
Hydrogen and oxygen from water. III - Bvaluation of a hybrid process	p0679 A80-49620
p0661 180-45298	Remote sensing applied to the prospecting of
Heavy water as a valuable by-product of	geothermal anomaly in Caldas Bovas County, State
electrolytic hydrogen	of Goias, Brazil
p0661 A80-47665	[INPE-1792-RPE/164] p0712 N80-3283
A system consideration of alternative hydrogen	HYDROLYSIS
storage facilities for estimation of storage costs	The CS/R advanced SNG hydrogasification process
p0661 A80-47666	p0674 A80-4829
Utilization of solar radiation for water photolysis	The MARK-13 process for hydrogen production
pJ661 A80-47667 Advanced coal liquefaction processes emphasize low	p0662 180-4841
hydrogen consumption	Development status of the General Electric solid
p0676 180-48380	polymer electrolyte water electrolysis technology p0662 A80-4841
Approach to steady-state solvent composition in	High-temperature water electrolysis for hydrogen
the SRC-I coal liquefaction process	production
p0676 A80-48382	p0662 A80-4841
Hydrogen storage in magnesium powder	The thermodynamics of aqueous water electrolysis
p0664 A80-50623	p0664 A80-5051
HYDROGENATION	Models for the photoelectrolytic decomposition of
Status of coal hydrogenation in Burope	water at semiconducting oxide anodes
, p0669 A80-45512 Status of coal hydrogenation outside Europe	p0664 A80-5051
p0669 A80-45513	Hydrogen production by the GA sulfur-iodine process [GA-A-15777-REV] p0666 M80-3165
Optimization studies of materials in hydrogenated	Assessment of sulfur removal processes for
amorphous silicon solar cells	advanced fuel cell systems
p0602 A80-46717	[EPRI-EH-1333] p0752 N80-3286
Contact formation, scaling and optimisation of	HYPERBARIC CHAMBERS
large-area R.F. sputtered a-Si Schottky barrier	The use of computer-controlled manipulators in
solar-cells	underwater technology
p0602 A80-46721	[DPVLR-HITT-78-02] p0714 N80-3411
Advanced coal liquefaction processes emphasize low	•
hydrogen consumption	
p0676 A80-48380	TCHTSTON
Approach to steady-state solvent composition in	IGHITION Autoignition characteristics of aircraft type fuels
the SEC-I coal liquefaction process p0676 180-48382	Autoignition characteristics of aircraft-type fuels
Liquid products from peat pyrolysis	[NISI=CR=159886] nA692 00A_3A63
ridii bidacts irom beat parorasis	[NASA-CE-159886] p0698 N80-3053
p0677 A80-48385	IGHITION TEMPERATURE
p0677 A80-48385	IGHITION TEMPERATURE On fusion alpha-particle heating of plasma below

p0677 A80-48429

p0718 A80-44429

SUBJECT INDEX INDUSTRIAL ENERGY

·	%
ILLUMINATING	INDION COMPOUNDS
Energy budget procedures and performance criteria	Short circuit current in indium tin oxide/silicon
for energy conserving building illumination systems	solar cells p0622 A80-50752
[PB80-184229] p0583 M80-31673 **ILIUMINATORS*** **Particular	INDION PROSPRATES Thin films of InP for photovoltaic energy conversion [COO-3004-2] p0642 N80-30912
<ul> <li>High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination</li> </ul>	[COO-3004-2] INDIUM PROSPHIDES High-efficiency InP homojunction solar cells
p0606 A80-46768	p0598 A80-46496
IMAGE PROCESSING Landsat imagery in oil exploration - Six years of	Oxide/semiconductor photovoltaic heterojunctions based on CdTe or InP
experience p0685 A80-50880	P0603 A80-46732
Urban solar photovoltaics potential: An inventory and modelling study applied to the San Fernando	Theory of an inductive free-field MHD propalsor p0737 A80-50666
Valley region of Los Angeles [NASA-CR-163436] p0636 N80-29859	INDUSTRIAL RERRGY Large-scale electrical energy storage
IMPLOSIONS	p0761 A80-44241
A model for laser driven atlative implosions p0735 A80-49069	Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31,
INCIDENT PADIATION  Generalization of the two-dimensional optical	1979, Compiled Papers p0570 A80-47585
analysis of cylindrical concentrators p0599 A80-46566	Energy from MSW - The industrial market Municipal Solid Waste
20 kW gallium arsenide photovoltaic dense array for central receiver concentrator applications	p0670 180-47588 Municipal solid waste as an industrial fuel
p0608 180-46793	p0670 A80-47589
General formula for the incidence factor of a solar heliostat receiver system p0622 A80-49758	High temperature heat pump applications - Commercial, industrial, and with alternative energy sources
Solar radiation incident on tilted flat surfaces	p0670 A80-47590
in Barcelona, Spain	Energy conservation and environmental benefits of
p0625 A80-51684 INCINERATORS	thermal energy storage systems in the pulp and paper industry
An update on the City of Waukesha energy recovery	p0763 A80-48194
incinerator plant	Economic analysis of coal burning fluidized bed
p0670 A80-47591 Refuse incineration - A recycling process p0681 A80-49955	steam and by-product power generation systems for industrial facilities p0672 A80-48200
The advantages of using an incineration regulation	Design and operation of fluidised bed industrial
system to control the emission of toxic gases and steam generation in refuse incineration plants	boilers and hot gas producers p0672 A80-48202
p0574 A80-49961 The functional use of the heat generated by a refuse incineration plant as exemplified by the	Economics of wood energy systems for industries p0673 A80-48275 Industrial energy conservation with the natural
RIP Bamburg Stapelfeld p0681 A80-49962	gas-fueled molten carbonate fuel cell p0571 A80-48280
Waste handling Rijnmond - Fnergy production of a large-scale waste incineration plant	Energy savings in a rotary kiln in the production of cement through the addition of domestic waste
p0681 A80-49963	and sewage sludge
A refuse incineration plant in combination with district heating demonstrated by the Iserlohn Plant	p0574 A80-49958 Waste oil as a fuel p0684 A80-50032
p0681 A80-49964	Provision of electric power as a prerequisite and
Combined production of electrical energy and heat in municipal refuse incinerators in the greater	determining factor for safeguarding the industrial community and ensuring the economical
Paris area p0682 180-49965	development of the Third World p0575 A80-50824
Services rendered for waste incineration power plants technology and implementation exemplified	End-use matching of solar energy systems p0624 A80-51208
with the waste incineration heating power plant of the seaport of Bremerhaven	Development research program for clean industrial and transportation fuels from coal
P0682 A80-49966	[PE-2514-31] p0691 N80-28554
The potential in Denmark for substituting natural resources by waste incineration products	Cogeneration Technology Alternatives Study (CTAS). Volume 2: Analytical approach
p0682 A80-49974 Possibilities of high temperature waste incineration with the FLK-process	[NASA-CR-159766] p0741 N80-28859 The outlook for nuclear power [PB80-175755] p0579 N80-29156
p0682 A80-49989 Plants for energy and material recycling	Industrial application and assessment of waste energy recovery technologies
p0682 A80-49991 Flue gas recirculation as a means of improving the	p0745 N80-30886 A study of industrial hydrogen and syngas supply
solid waste incineration process p0688 A80-53057	systems
The coating industry: Energy savings with volatile organic compound emission control [TID-28706] p0579 N80-29833	Cogeneration Technology Alternatives Study (CTAS). Volume 3: Energy conversion system characteristics
Biomass energy production. Citations from the International Aerospace Abstracts data base	[NASA-CR-159761] p0748 N80-31869 Cogeneration Technology Alternatives Study (CTAS).
[PB80-810807] p0711 N80-32578	Volume 3: Industrial processes
INDIA Application of remote sensing techniques to petroleum exploration in India	[NASA-CR-159767] p0749 N80-31870 Pilot study to select candidates for energy. Conservation research for the chemical industry
p0686 A80-51088	[DOE/TIC-11114] p0584 N80-31940
INDIVE	Large wind turbine generator performance assessment
Investigation of low-cost solar cells based on Cu20 [DOE/ET-23006/3] p0653 M80-32915	[EPRI-AP-1317] p0751 N80-31960

· ·	•
Use of solar energy to produce process heat for	Possibilities of high temperature waste
industry [SEBI/TP-731-626] p0651 N80-32863	incineration with the PLK-process p0682 A80-49989
Comparison of solar-thermal and fossil	The Wetox process for energy recovery from sewage
total-energy systems for selected industrial	sludge and industrial waste streams
applications	p0683 A80-49998
[ORNL/TH-7022] p0586 N80-32871	Thermodynamic and economic analysis of heat pumps
Potential for supplying solar thermal energy to industrial unit operations	for energy recovery in industrial processes [ASME PAPER 78-WA/HT-64] p0686 A80-52049
[SEBI/TP-632-584] p0588 880-32911	[ASME PAPER 78-WA/HT-64] p0686 A80-52049 Trace element characterization of coal wastes
International energy indicators	[PB80-166150] p0577 N80-28488
[DOE/IA-0010] p0588 880-32518	Solubility of selected major and minor elements
US National Photovoltaics Program and applications	from coal and fly ash accumulations
experiments in the intermediate sector [SAND-80-0587C] p0654 N80-32935	[PB80-175334] p0580 N80-29926
[SAND-80-0587C] p0654 N80-32935 Simulation of the energy-industry-environment	Synthetic fuels from municipal, industrial, and agricultural wastes. Citations from the BTIS
system for limited economic regions, using the	data base
example of Baden-Wuerttemberg. Part 1: Data,	[PB80-811375] p0706 880-31660
model development adaptation	Synthetic fuels from municipal, industrial and
[IKE-K-54-20-PT-1] p0589 880-32974	agricultural wastes. Citations from the
Cogeneration Technology Alternatives Study (CTAS). Volume 4: Energy conversion systems	American Petroleum Institute data base [PB80-812365] p0711 N80-32579
[NASA-CR-159768] p0755 N80-33859	INDUSTRIES
Cogeneration Technology Alternatives Study (CTAS).	Capital formation for small wind energy conversion
Volume 6: Computer data. Part 2:	system manufacturers: A guide to methods and
Residual-fired nocogeneration process boiler	SOUICES
[NASA-CE-159770-PT-2] p0591 N80-33861  Energy Conservation-air pollution abatement project	[SERI/TE-98298-1] p0751 B80-32462 IBERTIAL PUSION (REACTOR)
p0592 N80-33939	Grad B focusing and deposition of relativistic
EDUSTRIAL PLANTS	electron beams
An update on the City of Waukesha energy recovery	p0717 A80-43972
incinerator plant	An engineering development plan for inertial
p0670 A80-47591 Sulfate aerosol production and growth in	confinement fusion p0733 A80-48496
coal-operated power plant plumes	Theoretical multiple beam overlap from channel
p0572 A80-48533	transport of intense particle beams
A theoretical study of the modelling and control	p0735_A80-49067
of a solar water electrolysis plant p0621 A80-48919	Relativistic-electron-beam/target interaction in
Co-combustion trials of pretreated solid urban	plasma channels p0735 180-49068
refuse, on a brown coal-fired boiler	IMPORMATION SYSTEMS
p0681 A80-49957	Material-flow data structures as a basis for
The functional use of the heat generated by a	energy information system design
refuse incineration plant as exemplified by the BIP Hamburg Stapelfeld	[LBL-10248] p0760 N80-31923 IMPBARED IMSPECTION
p0681 A80-49962	Thermographic techniques applied to solar
Waste handling Rijnwond - Energy production of a	collector systems analysis
large-scale waste incineration plant	[SERI/TP-351-540] p0655 B80-32946
p0681 A80-49963	IMPRARED LASERS
A refuse incineration plant in combination with district heating demonstrated by the Iserlohn	Reflectance measurements on laser-produced plasmas at 0.26 micron
Plant	p0741 A80-53870
p0681 A80-49964	INGOTS
Effluent-free flue gas scrubbing process to	High temperature thermal energy storage in steel
separate the fine dust and the noxious gases	and sand
from waste combustion plants	[MASA-CR-159708] p0776 H80-29860 Low-cost solar array project and Proceedings of
Pittsburgh Energy Technology Center	the 15th Project Integration Meeting
hydrogasification process: Conceptual	[MASA-CR-163568] p0650 N80-32852
connercial scale plant design	INHONOGENEITY
[DOE/NC-08484/T1] p0703 N80-31633	Degradation of solar cell performance by areal
Coal demonstration plants [DOB/FE-0004/79-2] p0709 880-32555	inhomogeneity p0624 A80-51112
HDUSTRIAL SAPRTY	INLET PLON
Safety of wind energy conversion systems (WECS):	Performance of an inlet manifold for a stratified
Preliminary study risk to personnel and to	storage tank
the surrounding area due to mechanical failure [PPA-HU-2126] p0742 N80-28933	[ASME PAPER 79-HT-67] p0597 A80-45728 INLET PRESSURE
Health requirements for advanced coal extraction	The operating region of BHD generators
systems	p0739 A80-51721
[NASA-CR-163625] p0714 H80-34093	IBORGABIC COMPOUNDS
EDUSTRIAL WASTES	Active heat exchange system development for latent
Environmental protection - Cooperation versus enactments	heat thermal energy storage [NASA-CR-159727] p0775 N80-29857
p0569 A80-43843	INSOLATION POVIS NOT 29057
Large advanced waste treatment plants	Computer simulation of solar pond thermal behavior
p0569 A80-44412	p0599 A80-46567
Status report on the research programme 'New .	Total and non-isotropic diffuse insolation on
processes of thermal waste treatment* p0680 A80-49937	tilted surfaces
Refuse incineration - A recycling process	Simulation and a preliminary comparison of passive
p0681. <u>A80-49955</u>	solar heating systems
The combustion engineering approach to municipal	[ASME PAPER 80-HT-17] p0611 A80-48008
solid waste energy recovery p0681 A80-49959	Daily irradiations measured on three photovoltaic
The qasification of municipal and industrial waste	systems in Toulouse p0620 A80-48791
in accordance with the SPW-PUNK-Process	Solar radiation incident on tilted flat surfaces
p0682 A80-49979	in Barcelona, Spain
	p0625 180-51684

p0625 480-51684

SUBJECT 18DBY IRRIGATION

•	
Estimating solar irradiation sums from sunshine and cloudiness observations	INVESTMENTS The challenge of financing geothermal development
p0625 A80-51685 Energy savings obtainable through passive solar	p0727 A80-48317 Financing of energy investments - Capital and
techniques [LA-OR-80-746] p0632 H80-28891	policy requirements of developing countries p0573 A80-49395
Solar energy system economic evaluation for	The investment needs of the coal industry of the European Community
Elcam-Tempe, Tempe, Arizona and Elcam-San Diego, San Diego, California	p0573 A80-49399
[NASA-CA-161492] p0644 N80-31872 Terrestrial photovoltaic power systems with	IOS CICLOTRON BADIATION Parametric decay into ion cyclotron waves and
sunlight concentration	drift waves in multi-ion species plasma
[SAND-80-7008] p0648 N80-31942 Environmental data for sites in the National Solar	p0735 A80-49071 Parametric excitation of ion quasi-mode by the
Data Network	pump near the ion cyclotron frequency plasma
[SOLAR/0010-80/02] p0649 #80-31975 Installation, operation, and maintenance for the	heating in tokamaks p0736 A80-49072
pyramidal optics solar system installed at Yacht	IOB BICHARGING Development of new catalysts for coal liquid
Cover, Columbia, South Carolina [NASA-CR-161203] p0657 N80-33864	refining
INSTRUMENTS Instrumentation and process control development	[PE-2595-5] p0710 880-32569
for in situ coal gasification	· Ion implanted solar cells from EFG silicon ribbons
[SAND-80-0482] p0692 N80-28562 INSCLATION	Epitaxial Film Growth p0601 A80-46705
Development of polyimide materials for use in solar energy systems	Effect of laser irradiation on the characteristics of implanted Jayers for silicon solar cells
[DOB/CS-35305/T2] p0636 N80-29870	p0602 180-46711
INTEGRATED ENERGY SYSTEMS Biomass - Future developments	Photovoltaic technology development for synchronous orbit
p0687 A80-52858	p0657 N80-33470
Installation guidelines for solar heating system, single-family residence at William OBrien State	IOBIZED GASES Performance characteristics of nonequilibrium MHD
Park, Stillwater, Minnesota [NASA-CR-161480] p0630 N80-28861	generator with fully ionized seed and enlargement of stabilized region
INTELSAT SATELLITES	p0739 A80-51465
Status of COMSAT/INTELSAT mickel-hydrogen battery technology	IONOSPHERIC DISTURBANCES Solar power satellites - The ionospheric connection
P0770 A80-48437	p0757 A80-46397
INTELSAT 5 SATELLITE Nickel-hydrogen batteries for INTELSAT V	IONOSPHERIC PROPAGATION  Effects of microwave beams on the ionosphere
p0770 A80-48438	p0757 A80-46881
Hydrogen storage in a beryllium substituted TiFe	Heating requirements and estimations of solar
compound p0661 A80-45060	energy available in Iran p0620 180-48792
INTERNAL COMBUSTION ENGINES	IRON
Hydrogen engine performance analysis project [SAN-1212-T1] p0665 N80-30756	An advanced technology iron-nickel battery for electric vehicle propulsion
Comparative analysis of aluminum-air battery propulsion systems for passenger vehicles	p0766 A80-48327 Use of generalized population ratios to obtain Fe
[UCRL-52933] p0778 N80-32907	XV line intensities and linewidths at high
Analysis of aluminum-air battery propulsion systems for passenger vehicles	electron densities p0735 180-48763
[UCRL-83824] p0778 N80-32940 INTERNATIONAL COOPERATION	Experimental evidence of charge-exchange recombination of highly ionized iron and
U.S./U.S.S.R. joint MHD generator testing at the	titanium in Princeton large torus
U-25 MHD pilot plant	p0735 A80-48765
A new era in technology; Proceedings of the	Calcium/iron disulfide secondary cells
Seventeenth Space Congress, Cocoa Beach, Fla., April 30-May 2, 1980	p0764 A80-48239 Development of advanced batteries at Argonne
p0781 180-51926 Solar opportunities - Domestic and international	Fational Laboratory [ANL-80-32] p0776 N80-30927
p0625 A80-51951	IRON OXIDES .
RTG power source for the International Solar Polar	Note on the condensation of the vapor phase above a melt of iron oxide in a solar parabolic
Mission	concentrator p0611 A80-47664
P0727 A80-48305 INTERNATIONAL SUB SARTE EXPLORERS	IRRADIANCE
Design and performance of the International Sun-Earth Explorer power systems	Irradiance on the receiver of a general optical concentrator
p0765 A80-48307	p0610. A80-47043
INVESTIONS Patent profiles: Solar energy	Solar radiation incident on tilted flat surfaces in Barcelona, Spain
[PB80-190010] p0649 N80-31966	p0625 A80-51684
INVERTED CONVERTEES (DC TO AC)  Dc to ac power conditioning for photovoltaic	IRRADIATION  Estimating solar irradiation Sums from sunshine
arrays and utility interfacing p0605 A80-46744	and cloudiness observations p0625 A80-51685
Influence of metecrological conditions on the	IRRIGATION
design of solar energy dc-ac inverters	A horizontal axis sail windmill for use in irrigation
INVERTERS	[NAL-TH-54] p0743 N80-29844
Open-cycle HHD power conditioning and control requirements definition	Design, construction, and operation of a 150 kW solar-powered irrigation facility, phase 2
[BPRI-AF-1345] p0752 N80-32864	[ALO-4159-1] p0645 N80-31903
•	Solar powered rankine cycle irrigation pump

ISOMERIEATION SUBJECT INDEX

	•		
ISOMERISATION Organic photochemical storage of sol		Potential economics of large space power stations	
[COO-4380-3] ISOTHERMAL PROCESSES Over 50% efficiency achieved in gas	p0632 M80-28905 turbine system	The solar power satellite concept - decade and the next decade	p0617 A80-4835 The past
using isothermal expansion	p0724 A80-48249	Bockwell Satellite Power System /SP	p0623 A80-5095 S/ concept
The 1980 technology status of the Dy Power System	namic Isotope	definition studies  SOLARES orbiting mirror system	p0623 A80-5095
<u>-</u>	p0725 A80-48255	[AAS 79-304]	p0626 A80-5228
ISOTEOPY New method to determine the independ	lant char	- Technology for large space systems.	
moduli of transversely isotropic m [CONF-800575-1]		bibliography with indexes, supple [HASA-SP-7046(03)] Synchronous energy technology progr	p0649 B80-3241
	•	Large solar arrays	p0657 #80-3346
			p0657 880+3347
JAPAN OTEC research in Japan		LASER ABBEALING	charactori etico
Solar thermal electric power systems	p0718 A80-44600	Effect of laser irradiation on the of implanted layers for silicon s	
	p0620 180-48916	LASER APPLICATIONS	· -
<pre>Pinancing for energy resources devel     projects - Japanese experience</pre>		Improvement of phosphorus diffused cells by laser treatment	· ·
JET BHGINE PORIS	p0573 A80-49400	Laser technology: Development and	p0606 A80-4676
Comparison of alternate aviation fue [SAE PAPER 800767]	p0680 A80-49711	[GPO-59-826] LASER PUSION	p0781 N80-2969
Aircraft Research and Technology for [NASA-CP-2146]		A model for laser driven ablative i	p0735 A80-4906
Current jet fuel trends	p0694 180+29303	Momentum transfer of laser radiatio inhomogeneous dielectrics The	sis
Aviation fuels outlook	p0694 N80-29304	LASER HEATING	p0737 A80-5035
Military jet fuel from shale oil	p0694 N80-29308	Flash pyrolysis and gasification of laser heating	
Aviation turbine fuels, 1979 [DOB/BETC-PPS-80/2] Hydroprocessing of light pyrolysis f	p0703 N80-31627	Plash pyrolysis and gasification of laser heating	p0672 180-4824 coal through
kerosene type jet fuel	der off for	[LA-UR-80-1094]	p0711 #80-3257
[AD-A089101] JET BEGINES	p0713 H80-33599	LASER PLASMA INTERACTIONS	nnlegiens
JT9D-7A /SP/ jet engine performance	deterioration	A model for laser driven ablative i	p0735 A80-4906
trends	p0569 A80-44230	Momentum transfer of laser radiatio inhomogeneous dielectrics The	n to sis
JP-5 JET FUEL  Effect of refining variables on the	properties and	LASER PLASMAS	p0737 A80-5035
composition of JP-5	p0694 N80-29306	Use of generalized population ratio XV line intensities and linewidth	
JUICES		electron densities	-0735 100 5076
Carbohydrate crops as a renewable re fuels production. Volume 3: Juic	e preservation	Reflectance measurements on laser-p	p0735 A80-4876 roduced plasmas
[BMI-2031-VOL-3]	p0696 B80-29511	at 0.26 micron	
K		LASER BANGE PINDERS	p0741 A80-5387
KINETIC BHERGY		A study of the applicability/compat inertial energy storage systems t	
The new age of high performance kine storage systems	tic energy	missions [HASA-CR-163584]	p0777 #80-3285
	p0768 A80-48374	LASER TARGETS	
The photoklystron for satellite	solar energy	A model for laser driven ablative i	mplosions p0735 A80-4906
conversion	p0623 A80-50956	Momentum transfer of laser radiatio inhomogeneous dielectrics The	n to
L	-	Reflectance measurements on laser-p	p0737 A80-5035
		at 0.26 micron	-
LAMINATES Rotating strength of laminated compo	site discs	LASBES	p0741 180-5387
Theoretical study of absorbed solar	p0762 A80-47454	Advanced synfuels production/power utilizing laser particulate contr	
multi-layer absorber coatings for solar concentrators. II - Heat tra		[BNL-27783] Lasieg	p0710 N80-3257
[ASME PAPER 80-HT-105]	p0612 A80-48034	Solaser power solar energy lasi	ng in space p0622 180-5062
Preliminary comparative assessment o		LEAD ACID BATTERIES	
the Satellite Power System (SPS) a electric energy technologies (NISLE-D-163327)	nd alternative	Lead-acid battery expander. I - Ele evaluation techniques	
[NASA-CR-163327] micro-level land use impacts of bioc	conversion	Analysis of small, nonconventional	p0761 A80-4713 electric power
[LA-UR-80-1426]	p0709 N80-32562	systems for remote site applicati	ODS
Environmental implications of electr supply plans, 1978-2000 [PB80-192156]	p0588 N80-32963	Low maintenance lead-acid batteries storage	p0765 180-4827 for energy
LARGE SPACE STRUCTURES			p0765 A80-4832
Environmental effects of space syste	ns - A review p0757 A80-46880		
•	PA131 WOM-4000A	•	

SUBJECT INDEX LITHIUM

Evdration of 'spent' limestone and dolomite to Lead-acid traction batteries for electric road vehicle propulsion Directions for research and enhance sulfation in fluidized-bed combustion p0672 A80-48172 p0772 A80-48766 Application of the lime/limestone flue gas desulfurization process to smelter gases Lead batteries. Citations from the BTIS data base [PB80-813363] p0780 N80-33923 Lead batteries. Citations from the Engineering Index data base [PB80-813371] Magnetic-pressure acceleration of cylindrical liners by the pulse generators for relativistic D0780 W80-33924 LEARNING CURVES electron beams p0736 A80-49098 Design, engineering and evaluation of refractory liners for slagging gasifiers [IITRI-M6043-51 Investigation of learning and experience curves p0646 B80-31911 [SERI/TR-353-459] Working papers, appendices 15-17 [PB80-184542] The direct use of coal. [ IITRI-M6043-5 ] LINKAGRS D0697 N80-29523 Synthesis of four bar linkages for solar tracking LICENSING p0624 A80-51677 Patent profiles: Solar energy [PB80-190010] LIFE CYCLE COSTS LIQUEFACTION Biomass liquefaction efforts in the United States
[LBL-10456] p0696 B80-29512
LIQUEFIED NATURAL GAS p0649 N80-31966 The design of photovoltaic systems for residential LNG cold, an unutilized energy potential ---Liquid Batural Gas for electric power plants p0671 A80-47776 applications in the United States p0602 A80-46716 Design, performance and life cycle cost relationships for a 500kW space solar array Trends in financing LNG projects p0617 A80-48356 P0573 A80-49398 Alternative energy futures. Part 1: of liquefied natural gas imports Life cycle test of Air Force nickel-hydrogen The future flight experiment battery [ PB80-173552] p0771 A80-48443 Study of gelled LNG --- characterization of gelled LNG with respect to process, flow, use Bnergy conservation measures for commercial buildings used in life cycle cost analysis p0571 A80-48514 properties, and safety
[DOB/EY-02057/T2]
[DOB/EY-02057/T2]
[DOB/EY-02057/T2]
[Investigation of sulfur-tolerant catalysts for selective synthesis of hydrocarbon liquids from coal-derived gases Life cycle cost analysis in residential buildings p0695 N80-29506 and consumer appliances p0572 A80-48515 Solar energy system economic evaluation final report for SEMCO-Loxahatchee, Loxahatchee National Wildlife refuge, Palm Beach County, [FE-14809-1] p0702 M80-31502 Perspectives on research on LNG vapor cloud Plorida
[NASA-CR-161512] dispersion p0641 N80-30894 p0590 N80-33593 LIPE SCIENCES Vapor cloud explosion studies in the United States p0590 #80-33595 Technology Assessment. Citations from the NTIS AIRONHA DIDOLL data base [PB80-813165] p0783 N80-34299 Ammonia/water absorption cycles with relatively Technology Assessment. Citations from the NTIS high generator temperatures data base p0625 A80-51682 [PB80-813173] LIQUID COOLING D0783 N80-34300 LIPT The economics of aquifer storage of chilled water for air conditioning The mist-lift OTBC cycle p0767 A80-48337 Closed-cycle gas turbines for power generation and DO718 A80-44602 LIPTING BODIES Solar hot air balloons LNG vaporization D0628 A80-52841 D0739 A80-52600 LIQUID FURLS LIGHT BEAMS Theoretical multiple beam overlap from channel Oversight: Alternate liquid fuels technology [GPO-50-313] transport of intense particle beams D0590 N80-33580 D0735 R80-49067 Prospects for hydrogen aircraft LIGHTING ROUIPERNT for energy conserving building illumination [ SAE PAPER 800756] p0664 A80-49704 LIQUID METALS Liquid-metal MHD for solar and coal - System and systems FB80-1842291 component status p0583 #80-31673 LIGHITE p0724 A80-48226 An engineering development plan for inertial confinement fusion Reaction modelling and correlation for flash hydropyrolysis of lignite p0678 A80-48433 p0733 A80-48496 The flash hydropyrolysis of lignite and Piston type magnetohydrodynamic motor p0739 A80-52556
Thermoelectric MHD with walls parallel to the sub-bituminous coals to both liquid and gaseous hydrocarbon products p0679 A80-49626 magnetic field The utilisation of oil shale and lignite as low D0739 A80-52971 LIOUID HASTES grade fuels in a cyclone furnace Biogas from residues of animal husbandry and agricultural plant production p0685 A80-50963 The technical and economic aspects of brown coal p0683 A80-49994 refinement P0686 A80-51498 Recycling of effluents and organic residues into methane by anaerobic digestion - New perspectives The long-term effects of trace elements emitted by energy conversion of lignite coal [PB80-168867] p0683 180-49995 The Netox process for energy recovery from sewage sludge and industrial waste streams P0578 #80-28958 The long-term effects of trace elements emitted by energy conversion of lignite coal. Volume 2: Technical appendices p0683 A80-49998 LITHIUM [PB80-168875]
Chemistry of lignite liquefaction
[PE-2211-11] Hybrid lithium/nickel-zinc large missile ground P0579 N80-28960 power source p0772 A80-48489 p0704 N80-31642 LIBESTONE Safety studies on Li/SO2 cells. IV -Methods of improving limestone utilization in Investigations of alternate organic electrolytes fluidized-bed combustion for improved safety p0672 A80-48170 p0737 A80-50507

Safety studies on Li/SO2 cells. V - Effect of design variables on the abuse resistance of hermetic D cells	LOW TEMPERATURE TESTS  Evaluation of cranking characteristics of commercially available batteries between room
p0737 180-50509 Lithium batteries. Citations from the HTIS data base	temperature and -40 C [AD-A080614] p0780 N80-3390 LOWER IONOSPHERE
[PB80-812399] p0779 N60-32967 Lithium batteries. Citations from the Engineering	Effects of microwave beams on the ionosphere p0757 A80-4688
Index data base [PB80-812407] p0779 H80-32968	LUBBICANTS Potential of diesel engine, 1979 summary source
LITHIUM ALLOIS Development of advanced batteries at Argonne	document [PB80-193659] p0585 N80-3273
Hational Laboratory [ANI-80-32] p0776 N80-30927	LUBRICATING OILS  Why new technology to rerefine waste lubricating of
Some chemistry in the Li/SOC12 cell	p0685 A80-5003
p0774 A80-51688	M
Testing of sintered LiAlO2 structures in molten carbonate fuel cells	MAGMA Magma energy: A feasible alternative
p0721 A80-47143	[SAND-80-0309] p0693 #80-2887
<pre>Recent progress in lithium/iron sulfide battery   development</pre>	<b>HAGHESIUM</b> Hydrogen storage in magnesium powder
p0762 A80-48188	p0664 A80-5062
Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate	Automotive storage of hydrogen using modified magnesium hydrides
p0774 A80-51690	[SAN-1167-1] p0666 N80-3165
Alternate synthesis of electrolyte matrix for molten carbonate fuel cells	Conceptual design of RST: An rf-driven, steady-state Tokamak
p0721 A80-47135	[EPRI-AP-1351] p0751 M80-3223
Cycle life studies of LiAl/FeS cells using BN felt separators	Magnetic-pressure acceleration of cylindrical finers by the pulse generators for relativistic
p0763 A80-48189	electron beams
Optimization studies of lithium/iron sulfide cells for electric vehicle applications	p0736 A80-4909 MAGNETIC FIELD CONFIGURATIONS
p0763 A80-48190 New approach to electrode current collection for	Form factor for certain types of toroidal solenoids in tokamak fusion devices
LiAl/iron sulfide cells p0763 A80-48191	p0721 A80-4723 Theory of an inductive free-field HHD propulsor
Development of a tubular lithium-iron sulfide cell p0763 A80-48192	p0737 A80-5066
Scaling up of bipolar lithium/iron disulfide cells p0763 A80-48193	Thermoelectric MHD with walls parallel to the magnetic field
The lithium-sulfuryl chloride battery - Discharge behaviour	p0739 A80-5297 The SHIAS magnetic bearing wheel
p0772 A80-48770 LOADS (FORCES)	[SNIAS-792-421-101] p0775 N80-2892 Passive radially centered magnetic suspension for
An investigation of wind loads on solar collectors [PB80-158744] p0633 B80-28936	high velocity rotors [SNIAS-792-422-109] p0775 N80-2893
An investigation of wind loads on solar	BAGHETIC INDUCTION
collectors. Appendix 1: Data listing for top and bottom of collector	Contribution to the theory of the free-field induction-type MHD engine
[PB80-158751] p0633 N80-28937	p0736 A80-4941 Theory of an inductive free-field MHD propulsor
Determining the optimum design of the solar	p0737 A80-5066
modulator solar house reflective louver p0626 A80-52830	MAGNETIC MIRBORS The Tandem Mirror Pusion Test Pacility
LOW COST  Low cost crystalline silicon for solar cells	p0720 180-4585 Interfacing the Tandem Mirror Reactor to the
p0600 A80-46703 Research issues for low cost photovoltaic cells	sulfur-iodine process for hydrogen production p0662 A80-4840
p0605 A80-46748 Some characteristics of low-cost silicon sheet	Materials considerations for the coupling of thermochemical hydrogen cycles to tandem mirror
p0605 A80-46756 A preliminary 'test case' manufacturing sequence	reactors p0662 180-4840
for 50 cents/watt solar photovoltaic modules in 1986	Scoping study of a tandem-mirror fusion reactor coupled to a thermochemical hydrogen synfuel plan
p0607 A80-46771 Development of a tubular lithium-iron sulfide cell	p0662 A80-4840 Assessment of the US Mirror Fusion program.
p0763 A80-48192 Thin film solar cells	Report of the 1980 Mirror Senior Review Panel
p0619 A80-48513	[DOE/RR-0057] p0748 N80-3121 Tandem mirror fusion-fission hybrid studies
Low-cost flywheel demonstration program [DOB/ET-26931/T1] p0778 N80-32897	[UCBL-84018] p0754 N80-3323 HAGNETIC SHIELDING
LOW TEMPERATURE  Heat pumps in low temperature applications	Environmental protection of the solar power satellite
using geothermal resources	p0609 A80-4689
p0723 A80-48184 Analysis of binary thermodynamic cycles for a	#AGHETIC SURVEYS A multi-site magnetotelluric measurement system
moderately low-temperature geothermal resource p0725 A80-48267	with real time data analysis p0714 N80-3398
Heat pumps in low temperature applications [CONF-800806-7] p0711 N80-32699	HAGNETIC SUSPENSION LOW-cost flywheel demonstration program
LOW TEMPERATURE ENVIRONMENTS	[DOE/ET-26931/T1] p0778 E80-3289
Utilization of low temperature insulators and seals in thermionic converters	
p0732 A80-48474	

SUBJECT INDEX MAINTENANCE

	•
AGHETOHYDRODYHAMIC FLOW Study of the insulating wall boundary layer in a	A parametric study of 1000 MWe combined closed cycle MHD/system electrical power generating plants
Faraday MHD generator p0722 A00~47763 Alteration of Pfirsch-Schlueter transport in tokamaks by all four external sources	[TH-78-E-91] p0742 B80-2893 Joule heating effects in the electrode wall boundary layer of MBD generators
p0735 A80-49058 Relativistic-electron-beam/target interaction in plasma channels	p0743 H80-2962 The dispersion relation of electrothermal waves in a nonequilibrium magnetohydrodynamic plasma
p0735 A80-49068 Thermoelectric MBD with walls parallel to the magnetic field	closed cycle magnetohydrodynamic generators [TH-78-E-92] p0744 #80-3019 Thermionic energy conversion. Citations from the
p0739 A80-52971 IAGUETOHYDEODYNAMIC GENERATORS	MIIS data base [PB80-810906] p0747 M80-3095.
Parametric study of prospective early commercial OCMHD power plants /PSPEC/	Magnetohydrodynamic generators in power generation. Citations from the NTIS data base
P0717 A80-44106 Results from study of potential early connectial MHD power plants and from recent ETF design work	[PB80-810856] p0748 M80-3095 MHD electrode development [PE-15529-5] p0748 M80-3122
Engineering Test Facility p0717 A80-44107	Characterization of open-cycle, coal-fired MHD generators
Magnetoplasma compressor with an explosion-driven magnetic power generator	[ARI-RP-43] p0750 B80-3193 Tests of a lightweight 200 kW MBD channel and
p0717 A80-44185 Closed Cycle MHD power plant and retrofit	diffuser [AD-A087022] p0751 N80-3222
optimization application p0717 A80-44231	MHD high performance demonstration experiment [FE-2895-7] p0751 N80-3223
Experiments on H2-02 MHD power generation	Characterization of open-cycle, coal-fired MHD
p0717 A80-44239 Cathode sheaths in potassium seeded MHD combustion	generators [ARI-RP-46] p0751 N80-3223
plasmas	Open-cycle MHD power conditioning and control
p0720 A80-46158 Study of the insulating wall boundary layer in a	requirements definition [EPRI-AP-1345] p0752 N80-3286
Paraday MHD generator	Open-cycle MHD systems analysis
p0722 A80-47763 Comparison of use of Hottel chart and the zone	[BPRI-AP-1316] p0753 M80-3288 Engineering test facility conceptual design
method for radiative heat transfer in our open	for magnetohydrodynamic generators
cycle MHD radiant boiler [ASME PAPER 80-HT-44] p0722 A80-48022	[DOE/PR-2614/3] p0753 N80-3294 Pseudo-shock as a qualitative model in the
Heat transfer as a diagnostic tool in the	investigation of the influence of wall roughness
development of direct coal-fired MHD combustors [ASME PAPER 80-HT-125] p0722 A80-48040	on the performance of supersonic MHD generators [AD-A088333] p0754 M80-3322
Open-cycle MHD generator channel development p0723 A80-48185	MAGHETOHIDRODYNAMIC STABILITY  CT-6 tokamak research - Development and test
Development of steam generator components for open-cycle MHD	operation of the experimental device p0718 A80-4434
p0723 A80-48186	Linear analysis of the double-tearing mode in
Component nevelopment and Integration Pacility - A description and status report on coal-fired	tokamak discharges p0718 A80-4439
open cycle MHD plant p0723 A80-48187	Combined n equal to 0 and n not equal to 0 MHD stability analysis of axisymmetric surface
U.S./U.S.S.R. joint MHD generator testing at the	current model equilibria
U-25 MBD pilot plant p0724 A80-48223 Development of the high temperature air heater for	pO719 A80-4465 Absolute dissipative drift-wave instabilities in tokamaks
open cycle MHD p0724 A80-48224	p0719 A80-4466 Eigenvalue bounds for Hill's equation in
Near term commercialization of MHD power generation using coal/oil fuel	stability theory for magnetohydrodynamic equilibria
p0724 A80-48225 Liquid-metal MHD for solar and coal - System and	p0720 180-4585 Heat transfer as a diagnostic tool in the
component status	development of direct coal-fired MHD combustors
p0724 A80-48226 Contribution to the theory of the free-field	[ASME PAPER 80-HT-125] p0722 A80-4804 The Spheromak fusion reactor
induction-type MHD engine p0736 A80-49414	p0733 A80-4849 Parametric decay into ion cyclotron waves and
Instability analysis in a nonequilibrium MHD generator Thesis	drift waves in multi-ion species plasma p0735 A80-4907
p0737 A80-50357 Theory of an inductive free-field MHD propulsor p0737 A80-50666	Destabilization of drift-universal eigenmodes by toroidal effects p0736 A80-4920
Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A60-50947	Instability analysis in a nonequilibrium HHD generator Thesis p0737 180-5035
End effects in a MHD channel with diverging electrode walls	MAGERTOHYDRODYNAMICS  Rapporteur report: MHD electric power plants
p0736 A80-50948 Performance characteristics of nonequilibrium BBD generator with fully ionized seed and	[NASA-TH-81554] p0743 N80-2986 MAGNETOPLASHADINANICS A study of the applicability/compatibility of
enlargement of stabilized region p0739 A80-51465	inertial energy storage systems to future space missions
The operating region of MHD generators p0739 A80-51721	[HASA-CR-163584] p0777 N80-3285 HAISTENARCE
End zone of a frame-type channel with an inhomogeneous flow current and potential	Management of a large, operational solar pond p0617 A80-4836 Laboratory demonstration of self-creation,
fields in plasma p0739 &80-52555	self-maintenance and self-correction of saturated solar ponds
Piston type magnetohydrodynamic motor p0739 A80-52556	p0618 A80-4836

p0618 A80-48366

Operation and maintenance cost data for residential photovoltaic modules/panels [NASA-CE-163585] p0650 N80-32855  HAE REVIRORMENT INTERACTIONS	Department of Housing and Urban Development solar hot water initiative: Centralized coordination of technical tasks and system evaluation [PB80-189244] p0656 N80-32961
The global 2000 report to the president. Entering the twenty-first century. Volume 2: The technical report trends in population, climate, gross national product, earth	A proposed slotted mask for direct deposition of metal contact pattern on MIS solar cells p0595 A80-45119
resources, technology, and man environment interactions	MASS SPECTROMETERS Characterization of open-cycle, coal-fired MHD
p0782 N80-32296 A methodology for the environmental assessment of advanced coal extraction systems [NASA-CE-163570] p0586 N80-32827	generators [ARI-RP-46] Use of an automated mass spectrometer for an underground coal gasification field test
MANAGEBERT Alternative metering practices. Implications for conservation in multifamily residences	[UCRL-84366] p0709 N80-32565  BASS TRANSFER  Heat and mass transfer processes during the
[HCP/M1693-03] p0579 M80-29838 MANAGEMENT METHODS Capital formation for small wind energy conversion	pyrolysis of antrim oil shale [ASHE PAPER 80-HT-123] p0671 A80-48039 Simulation of mass transfer processes in
system manufacturers: A guide to methods and sources	geothermal power cycles with direct contact heat exchange
[SEEL/TE-98298-1] p0751 880-32462  MANAGEMENT PLANNING  Energy models as a tool for planning p0577 A80-54035	p0724 A80-48222 An investigation of simultaneous heat and mass transfer in subbituminous coal hot gas drying for underground coal conversion
Costing methodologies for energy systems [BNI-27603] p0778 N80-32900 NAMIFOLDS	p0676 A80-48344 Appraisal of the M factor and the role of building thermal mass in energy conservation
Performance of an inlet manifold for a stratified storage tank	[OBNL/CON-46] p0588 M80-32958 Modeling of heat and mass transfer during coal
[ASME PAPER 79-HT-67] p0597 A80-45728  ###################################	block gasification p0713 N80-33577
underwater technology [DFVLB-HITT-78-02] p0714 N80-34117 MABUFACTURING	LLL in situ coal gasification project [UCRL-50026-79-4] p0705 R80-31654 MATERIALS RECOVERY
A preliminary 'test case' manufacturing sequence for 50 cents/watt solar photovoltaic modules in	Methane recovery from urban refuse p0670 A80-47587
1986 p0607 180-46771 Cost-effective ways to improve the fabrication and	Removal of metals from coal ash  p0674 M80-48295  Recovery of ethanol from fermentation broths using
installation of solar heating and cooling systems for residences	selective sorption-desorption p0678 180-48516
[COO-4520-1] p0632 N80-28902 Capital formation for small wind energy conversion system manufacturers: A guide to methods and sources	Becycling World Congress, 2nd, Manila, Philippines, March 19-22, 1979, Proceedings p0678 180-49537 The producing mechanism, separative and fuel
[SERI/TR-98298-1] p0751 N80-32462 HARIBB TECHBOLOGY	characteristics of municipal refuse p0679 A80-49539
Ocean engineering developments for OTEC 10/40 MW spar platforms p0740 A80-53686	Recycling Berlin '79; Proceedings of the International Congress, Berlin, West Germany, October 1-3, 1979. Volumes 1 & 2
MARKET BESEARCE The potential global market in 2025 for Satellite	p0680 A80-49926 Energy and material recycling
Solar Power Stations p0598 A80-46382 Photowoltaics commercialization readiness assessment	p0680 A80-49927 State and tendencies of recycling in Borth America p0573 A80-49929
p0607 A80-46772 DOE view of solar power commercialization and applications	An analysis of criteria for evaluating proposals for recovery of material and energy from refuse p0574 A80-49931
p0629 A80-52870 Aspects of commercializing coal-derived methanol fuels in the United States, 1985 to 2000.	The efficiency of recovering energy and materials from solid waste p0574 A80-49933
Volume 1: Market evaluation [PE-2416-44-VOL-1] p0690 N80-28542 Aspects of commercializing coal-derived methanol	Application of the energy concept to a resource recovery system p0574 A80-49934
fuels in the United States, 1985 to 2000. Volume 2: Appendix	Anatomy of regional solid waste resource recovery projects
[FE-2416-44-VOL-2] p0690 N80-28543 User evaluation study of passive solar residences [SERI/TF-63-350] p0638 N80-29882	p0574 A80-49939 Plants for energy and material recycling p0682 A80-49991
Solar Central Receiver Hybrid Pover Systems sodium-cooled receiver concept. Volume 2, book	Use of gas from landfills for energy recovery - Operating experience at Palos Verdes
1: Conceptual design, sections 1 through 4 [DOE/ET-20567/1-2-BX-1] p0645 N80-31896 MARKETIEG	p0683 A80-49999 Co-firing densified refuse derived fuel in a spreader stoker fired boiler
Solar/hydrogen systems assessment. Volume 1: Solar/hydrogen systems for the 1985 - 2000 time frame	p0684 A80-50018 A method to reclaim metallic material and energy from automobiles
[NASA-CE-163392] p0665 N80-28865 Market penetration of energy supply technologies	P0684 A80-50024 Waste oil as a fuel
p0579 #80-29837 Assessment of Peruvian biofuel resources and alternatives	p0684 A80-50032 Why new technology to rerefine waste lubricating oil p0685 A80-50033
[ANL/EES/TH-86] p0708 N80-32547 Proceedings of the Ocean Energy Information Dissenination Workshop	
[SEBI/TP-732-600] p0753 H80-32956	

SUBJECT INDEX HEDICAL SCIENCE

The push-pull test - A method of evaluating formation adsorption parameters for predicting	Condensation processes in coal combustion products [DOE/ER-10456/1] p0708 N80-32473
the environmental effects on in-situ coal gasification and uranium recovery	Modeling and evaluation of designs for solid hydrogen storage beds
p0576 A80-52968  Peasibility study for industrial cogeneration fuel	[CONF-800616-8] p0666 N80-32554 Potential of spark ignition engine, effect of
cell application [SAN-1889-T1] P0746 N80-30934 Alcohol fuels. Citations from the Engineering	vehicle design variables on top speed, performance, and fuel economy [PB80-191836] p0586 #80-32736
Index data base [PB80-812449] p0711 N80-32581	Bending behavior of lapped plastic EHV cables [BHL-27331] p0760 N80-32789
Alcohol fuels. Citations from the Engineering Index data base	New method to determine the independent shear moduli of transversely isotropic materials
[PB80-812456] p0711 N80-32582 Assessment of sulfur removal processes for	[CONF-800575-1] p0712 N80-32796 Photovoltaic applications definition and
advanced fuel cell systems [EPBI-ZM-1333]	photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891
[PB80-813363] p0780 N80-33923 Lead batteries. Citations from the Engineering	Simulation model for assessing building energy-conservation policies
Index data base [PB80-813371] p0780 N80-33924	[BNI-27802] p0587 M80-32901 Development of the zinc-chloride battery for
MATHEMATICAL MODELS  Dynamics and control of a continuum model for a  solar power system	utility applications [EPRI-EM-1417]  Deposition, fabrication and analysis of
[AIAA 80-1740] p0757 A80-45534 Mid-range energy forecasting system - Structure,	polycrystalline silicon MIS solar cells [DOE/ET-23044/4] p0653 N80-32920
forecasts, and critique p0570 A80-46335	Line-focus solar central power system, phase 1. Subsystem experiment: Receiver heat transfer
Optimal material properties for CdS/Cu2S solar cells p0603 A80-46726 Numerical modelling of a solar cell in three	[DOE/BT-20550/1] p0655 N80-32945 Computer modeling of thermal storage walls [SERI/TP-721-610] p0779 N80-32949
dimensions p0605 A80-46749	Definition of gust model concept and review of gust models
A computer model for polycrystalline Si n/plus//p solar cells p0606 A80-46766	[PNL-3138] p0712 N80-33072 Perspectives on research on LNG vapor cloud dispersion
A model for laser driven ablative implosions p0735 A80-49069	p0590 N80-33593 Coal gasification combined-cycle system analysis
Energy conservation in terminal airspace through fuel consumption modeling	[EPRI-AP-1390] p0713 N80-33601 Evaluation of hydropower potential in a river basin
[SAR PAPER 800745] p0573 A80-49695 A simulation model for wind turbines p0738 A80-50972	Prediction analysis technique p0755 N80-33856 International Conference on Air pollution, Volume 4
OTEC power system modeling, analysis and design via geometric programming	p0592 N80-33954
p0739 A80-52048 A new probabilistic simulation technique for multiple energy storage devices for electric	Optimum OTEC design and sensitivity analysis using geometric programming p0741 A80-53688
utility generation system expansion planning models	MATRIX MANAGEBERT Fossil fuels research matrix program. US
p0774 N80-28855 Analysis of the influence of geography and weather	Environmental Protection Agency/Department of Energy Possil Puels Research Materials Facility
on parabolic trough solar collector design [SAND-79-2032] Sites for wind-power installations: Physical	[ORNI/TH-7346] p0583 N80-31632 MATRIX HETHODS  Dynamic analysis of a rotor blade with lead-lag
modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.	freedom, flapping freedom, and variable-controlled blade pitch angle
Fart 1: Executive summary [BL0-2438-78/1] p0706 N80-31900 Sites for wind-power installations: Wind	[ISD-258] p0747 N80-30950 BECHANICAL DEVICES The sun-mill - A version of dunking-bird as an
characteristics over ridges, part 2 [RLO-2438-78/2] p0706 N80-31901	energy convertor of sun's radiation p0596 A80-45459
Coal processing for fuel cell utilization: Task 9: One-dimensicnal (streamtube) model for entrained-flow gasifier analysis	Kinetics'and mechanisms of catalytic hydroliquefaction and hydrogasification of lignite [FE-2702-10] p0709 M80-32556
[METC-8450-T2-VOL-1] p0707 N80-31912 Absorption refrigeration machine driven by solar	BECHANICAL DRIVES Design study of steel V-Belt CVT for electric
heat [EUR-6748-EN] p0646 N80-31914	Vehicles [NASA-CR-159845] p0777 N80-32299
<ul> <li>Analytical modeling of line focus solar collectors [SERI/TP-333-591]</li> <li>Interactions between energy supply and</li> </ul>	MECHANICAL ENGINEERING Gas turbines for automotive use Book p0736 A80-50351
transportation-related energy use, volume 1 [PB80-185002] p0584 880-31968	MECHANICAL PROPERTIES  Photovoltaic module electrical termination design
Characterization of open-cycle, coal-fired MHD generators [ARI-RP-46] p0751 N80-32234	requirement study [JPL-955367-80/1] p0644 N80-31877 New method to determine the independent shear
Review of Department of Energy sponsored codes and documentation available from Purdue and Lehigh	moduli of transversely isotropic materials [CONF-800575-1] p0712 N80-32796
Universities processes modeling contracts [K/CSD/TM-35] p0707 N80-32278	MEDICAL SCIENCE Technology Assessment. Citations from the NTIS data base
The global 2000 report to the president. Entering the twenty-first century. Volume 2: The technical report trends in population,	[FB60-813165] p0783 N80-34299 Technology Assessment. Citations from the NTIS
climate, gross national product, earth resources, technology, and man environment	data base [FB80-813173] p0783 M80-34300
interactions p0782 N80-32296	•

MELTIEG	•	METAL-GAS SYSTEMS	
Heat transfer - San Diego 1979; Procee		Hydrogen in metals - Outstanding pro	perties and
Eighteenth Hational Conference, San Calif., August 5-8, 1979	Diego,	examples for utilization. II	p0661 A80-43842
	0781 A80-53568	MBTALLIC PLASMAS	p0001 200 43042
Bultiphase reactor modeling for zinc c	hloride	Use of generalized population ratios	
catalyzed coal liquefaction	0703 #00-31630	XV line intensities and linewidths electron densities	at high
[LBL-9870] P MELTS (CRISTAL GROWTE)	0703 N80-31628	election densities	p0735 A80-48763
Silicon web process development		BETALLIZING	•
	0631 N80-28864	A proposed slotted mask for direct d	
MRSAS Changes in the potential for wind ener		metal contact pattern on MIS solar	p0595 A80-45119
generation due to terrain modificati		Influence of the double exponential	
boundary-layer flow		efficiency and the yield of screen	
METABOLIC WASTES	0714 180-34020	cells energy conversion effect	iveness
Possil fuels research matrix program.	US	measurement	p0606 A80-46764
Environmental Protection Agency/Depa	rtment of	BETALS	•
Energy Possil Puels Research Materia		Metallic thermoelectric materials in	solar
[ORBL/TH-7346] p HETAL AIR BATTERIES	0583 N80-31632	thermoelectric generators	p0610 A80-47152
Development of a lithium-water-air pri	mary battery	Removal of metals from coal ash	, , , , , , , , , , , , , , , , , , ,
for automotive propulsion			p0674 A80-48295
The aluminum-air battery for electric	0768 A80-48372	ABTROBOLOGICAL PARAMETERS Influence of meteorological conditio	ne on the
propulsion	·enicie	design of solar energy dc-ac inver	
	0768 A80-48373		p0609 A80-46795
An analysis of aluminum-air battery pro	opulsion	Three computer codes to read, plot a	
systems for passenger vehicles	0771 A80-48471	operational test-site recorded sol [NASA-TM-78293]	ar data p0644 N80-31879
Oxygen electrodes for energy conversion		Environmental data for sites in the	
[DOE/ET-25502/1] P	0753 N80-32878	Data Network	
Comparative analysis of aluminum-air be		[SOLAR/0010-80/02]	p0649 B80-31975
propulsion systems for passenger web. [UCRL-52933] p	1Cles 0778 N80-32907	Development of a methane fermentation	n process for
Aluminum air battery for electric vehic		organic wastes	a process ror
. [UCBL-84443] P	0779 N80-32941		p0679 A80-49545
METAL COATINGS  Spectral effects on direct-insolation	a b a	Biogas from residues of animal husba	ndry and
of five collector coatings	ansorptance	agricultural plant production	p0683 A80-49994
	0597 A80-45722	Recycling of effluents and organic r	
Investigation of the service life of a		methane by anaerobic digestion - N	
mirrors on metal substrates at high			p0683 A80-49995
Investigation of the characteristics o	0611 A80-47158 . f	Shift conversion and methanation in gasification: Bench-scale evaluat	
electrochemical coatings for solar-ra		sulfur resistant catalyst	
, collectors		[ FE-3240-T5]	p0696 #80-29509
METAL HYDRIDES	0611 A80-47164	Methane recovery from coalbeds proje	
Hydrogen in metals - Outstanding proper	rties and	[DOE/NC-08089/T4]  Feasibility study: Fuel cell cogene.	p0705 N80-31645
examples for utilization. II		water pollution control facility,	
	0661 A80-43842	[DOB/ET-12431/T1-VOL-1.]	p0749 H80-31922
Hydrogen storage in a beryllium substi- compound	tuted Tire	METHANS Methane recovery from urban refuse	
	0661 A80-45060		p0670 A80-47587
A thermodynamic analysis of a metal hy	dride heat	Kelp processing and biomethanation to	
pump	0661 180-48290	Status of post biografication devol-	p0673 A80-48278
Hydrogen storage in magnesium powder		Status of peat biogasification devel	p0674 A80-48293
	0664 A80-50623	. Sorption of moisture and methane on :	
Automotive storage of hydrogen using me	odified	in underground coal conversion	
magnesium hydrides [SAN-1167-1] p	0666 B80-31650	Gas distribution equipment in hydrogen	p0676 A80-48346
Electrolysis-based hydrogen storage te		Phase II	
	0647 N80-31928		p0758 A80-48506
Modeling and evaluation of designs for hydrogen storage beds	solid	Methane production from urban solid	wastes p0683 A80-50000
	0666 N80-32554	Methane formation during hydrogen ga	
HETAL IONS		gas phase pyrolysis of selected ar	
Experimental evidence of charge-exchange		Alteration Con Bookshap	p0689 A80-54034
recombination of highly ionized iron titanium in Princeton large torus	and .	Alternative Gas Workshop [LA-8155-C]	p0690 N80-28547
	0735 A80-48765	Cryogenic methane separation/catalyt	
NETAL OXIDE SENICONDUCTORS		hydrogasification process analysis	
Oxide semiconductors in photoelectroche	emical	[FE-3044-T6] Alternative process schemes for coal	p0690 N80-28548
conversion of solar energy	0599 A80-46568	[BHL-51117]	p0692 N80-28560
Oxide/semiconductor photovoltaic heter		Shift conversion and methanation in	
based on CdTe or InP		gasification: Bench-scale evaluat	ion of a
Open-circuit voltage of induced-junction	0603 A80-46732	sulfur resistant catalyst [FE-3240-T4]	p0692 N80-28561
	0622 A80-50758	Liquid-phase methanol	P4032 B00-20301
METAL POUDER	· · · · ·	[ EPRI-AF- 1291]	p0692 N80-28567
Hydrogen storage in magnesium powder	066h 100-50622	Some advantages of methane in an airc	craft gas
Ρ'	0664 180-50623	turbine [HASA-TM-81559]	p0695 #80-29502
			*

SUBJECT INDEX MIS (SEMICONDUCTORS)

·	
Second phase of a ccalbed methane extraction and	MILITARY SPACECRAPT
utilization program [AESD-THE-3026] p0700 N80-30556	Puture space power - The D.O.D. perspective p0722 A80-48174
US Department of Energy's methane from landfills	Concentrating photovoltaics - A viable candidate
program [CONF-7910126-1] p0701 N80-30558	for the next generation of Air Porce satellite power systems
Cryogenic methane separation/catalytic	p0614 A80-48209
hydrogasification process analysis [FB-3044-T7] p0704 N80-31635	High voltage power systems for military needs solar energy conversion equipment
Methane recovery from coalbeds project, phase 2	p0725 A80-48254
[DOB/HC-08089/T4] p0705 N80-31645	Mission analysis of the F78-2 power subsystem
Methanol and methyl fuel catalyst [FE-3177-5] p0708 M80-32472	after one year of operation , p0765 A80-48310
Study of methane fuel for subsonic transport	MILITARY TECHNOLOGY
aircraft [NASA-CR-159320] p0708 N80-32533	Requirements for future Air Force satellite solar power technology
Automotive fuels from cellulose materials	p0604 A80-46736
[HZEHDC-49] p0710 H80-32571	MILLIMETER WAVES Observations of fluctuating omega sub p emission
Chem Systems liquid phase methanol process	in Alcator tokamaks
p0677 180-48383 Mobil methanol-to-gasoline process	p0736 A80-49075 Some perspectives on the use of powerful gyrotrons
p0677 A80-48384	for the electron-cyclotron plasma heating in
Investigation of the feasibility of methanol as an automobile fuel	large tokamaks p0738 A80-51038
p0688 180-52881	HIBERAL DEPOSITS
Aspects of Commercializing coal-derived methanol fuels in the United States, 1985 to 2000.	Uranium resources: A review of estimation methodologies
Volume 1: Market evaluation	[PB80-193725] p0714 N80-33920
[FE-2416-44-VOL-1] p0690 N80-28542 Aspects of commercializing coal-derived methanol	HIBERAL EXPLORATION  Electromagnetic methods in applied geophysics
fuels in the United States, 1985 to 2000.	p0669 A80-46170
Volume 2: Appendix [FB-2416-44-VOL-2] p0690 N80-28543	Remote sensing and mineral exploration; Proceedings of the Workshop, Bangalore, India,
Fuel cell applied research: Rlectrocatalysis and	May 29-June 9, 1979
materials [BNI-51053] p0742 N80-28920	p0686 A80-51076 A multi-site magnetotelluric measurement system
Preparation and stability of emulsions of methanol	with real time data analysis
in automotive diesel oil [PB80-169162] p0697 N80-29526	p0714 N80-33988 HIMES (RICAVATIONS)
Modifications for use of methanol or	Experimental studies of some regularities in the
methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 N80-32552	underground gasification of inclined coal seams [UCRL-TBARS-11585] p0695 N80-29504
Preparation and stability of emulsions of methanol	Intergenerational equity and conservation
in automobile diesel oil [CSIR-CBNG-294] p0713 N80-33579	[NASA-CR-163434] p0580 N80-29861 General application of the critical path method to
IETHIL COMPOUNDS	resource characterization and planning for
Hethanol and methyl fuel catalyst [FE-3177-5] p0708 M80-32472	underground coal mining [DOB/ET-11268/3] p0707 N80-32272
ICROPROCESSORS	Health requirements for advanced coal extraction
Large wind turbine generator performance assessment [EPRI-AP-1317] p0751 N80-31960	systems [NASA-CR-163625] p0714 N80-34093
IICROUAVE EMISSION	HINING
Observations of fluctuating omega sub p emission in Alcator tokamaks	Survey of world coal energy studies and international coal mining research
p0736 A80-49075	[FE-2468-68] p0691 N80-28551
MICROWAVE TRANSMISSION  Environmental effects of space systems - A review	Solubility of selected major and minor elements from coal and fly ash accumulations
p0757 A80-46880	[PB80-175334] p0580 N80-29926
Effects of microwave beams on the ionosphere p0757 A80-46881	A methodology for the environmental assessment of advanced coal extraction systems
Solar power satellites - The present and the future	[NASA-CR-163570] p0586 N80-32827
p0757 A80-47562 The first realistic solar energy project	MINNESOTA Installation guidelines for solar heating system,
p0758 A80-50994	single-family residence at William OBrien State
Satellite Power Systems (SPS): Concept development and evaluation program: Preliminary	Park, Stillwater, Minnesota [NASA-CR-161480] p0630 N80-28861
assessment	MINORITY CARRIERS
[NASA-TM-81142] p0759 N80-29842 Some questions and answers about the Satellite	New experimental evidence for minority carrier MIS diodes for solar cells
Power System (SPS)	p0600 A80-46695
[NASA-CE-163329] p0639 N80-29897 Satellite Power System (SPS) FY 79 program summary	MIRRORS Investigation of the service life of aluminum
[NASA-CR-163479] p0639. N80-29900	mirrors on metal substrates at high temperatures
Satellite Power Systems (SPS) concept definition study. Volume 7: System/Subsystem requirements	General formula for the incidence factor of a
data book	solar heliostat receiver system
[NASA-CR-3324] p0759 N80-30900 Satellite power systems (SPS) concept definition	p0622 A80-49758 SOLARES orbiting mirror system
study. Volume 1: Executive summary	[AAS 79-304] p0626 A80-52280
[NASA-CE-3317] p0759 N80-30901 Satellite power systems (SPS) concept definition	MIS (SEMICOMDUCTORS)  A proposed slotted mask for direct deposition of
study. Volume 2, part 1: System engineering	metal contact pattern on MIS solar cells
[NASA-CE-3318] p0760 N80-31890	p0595 A80-45119 Economic requirements for new materials for solar
Satellite power systems: Status and planned	photovoltaic cells
activities p0760 N80-33904	p0596 A80-45317 MIS and SIS solar cells on polycrystalline silicon
g 200 about	n0597 A80-46257

HISSION PLANNING SUBJECT. INDEX

New experimental evidence for minority carrier MIS diodes for solar cells	HOMESTUM TRANSFER Homentum transfer of laser radiation to
p0600 A80-46695 Progress in the development of the thin film MIS	inhomogeneous dielectrics Thesis p0737 A80-50356
solar cell based on CdSe	HOBITORS
p0603 A80-46728 On the influence of an interfacial oxide layer on	Instrumentation and process control development for in situ coal gasification
Au/n-Gals Schottky barrier solar cells	[SAND-80-0482] p0692 N80-28562
p0608 A80-46784 Surface passivation of inversion layer m.i.s.	ECTOR VEHICLES  Flywheel energy management systems for improving
solar cells	the fuel economy of motor vehicles
p0612 A80-48150	[PB80-175300] p0777 H80-31278
Development of a cadmium selenide thin film solar cell	Low-cost photovoltaic cell mount study
[BHFT-FB-T-79-72] p0640 880-29907	[SAND-80-7006] p0633 N80-28908
NASA program plan	BULTIMISSION MODULAR SPACECRAPT Nickel-cadmium batteries for the Modular Power
[ NASA-TH-81136 ] p0781 N80-31269	Subsystem of Multimission Modular Spacecraft
IIST The mist-lift OTEC cycle	p0769 A80-48398 Bickel-hydrogen battery integration study for the
p0718 A80-44602	Hultimission Modular Spacecraft
IODULATORS Determining the optimum design of the solar	p0770 A80-48441
modulator solar house reflective louver	· N
p0626 180-52830	N-TYPE SENICONDUCTORS
Testing flat plate photovoltaic modules for	Photoelectrochemical compatibility of n-WSe2 and
terrestrial environment	n-MoSe2 with various redox systems
OISTURE CONTENT	photodecomposition of semiconductor solar cell surface
Sorption of moisture and methane on Fruitland coal	P0610 A80-47141
in underground coal conversion p0676 180-48346	Hydrogen production by photoelectrolytic decomposition of H2O using solar energy
Experimental studies of some regularities in the	[NASA-CR-163586] p0667 N80-32854
underground gasification of inclined coal seams [UCRL-TRANS-11585] p0695 M80-29504	Progress in space power technology
OLTER SALT BLECTROLITES	p0722 A80-48173
Alternate synthesis of electrolyte matrix for molten carbonate fuel cells	The solar power satellite concept - The past decade and the next decade
p0721 A80-47135	p0623 A80-50951
Alternate fabrication process for molten carbonate fuel cell electrolyte structures	Status of the satellite power system concept development and evaluation program
p0721 A80-47136	p0623 A80-50952
Testing of sintered LialO2 structures in molten	NASA authorization, 1981, volume 5 [GPO-61-213-VOL-5] p0581 N80-30225
carbonate fuel cells p0721 A80-47143	[GPO-61-213-VOL-5] p0581 N80-30225 National Aeronautics and Space Administration
New approach to electrode current collection for	Authorization Act, 1981
LiAl/iron sulfide cells p0763 A80-48191	[PUB-LAM-96-316] p0581 N80-30226 NASA program plan
A new rechargeable high voltage low temperature	[NASA-TH-81136] p0781 N80-31269
molten salt cell p0764 A80-48237	EATURAL GAS Industrial energy conservation with the natural
Sodium-sulfur-aluminum chloride cells	gas-fueled molten carbonate fuel cell
p0764 A80-48238 Development of molten carbonate fuel cells for	p0571 A80-48280 Gas distribution equipment in hydrogen service -
power generation	Phase II
p0726, 180-48279 The kinetics of the 02/C02 reaction in molten	p0758 A80-48506 Use of gas from landfills for energy recovery -
carbonate - Beaction orders for 02 and CO2 on BiO	Operating experience at Palos Verdes
in fuel cells p0726 180-48284	p0683 A80-49999 The significance of the gas economy from the
Some chemistry in the Li/SOC12 cell	viewpoint of environmental protection
p0774 A80-51688  Fuel cell research on second-generation	p0575 A80-50821 Coordinating fossil fuel research in natural gas
molten-carbonate systems .	recovery
[SAH-11276-2] p0750 #80-31935 HOLTEN SALT NUCLEAR REACTORS	[PB80-169469] p0697 B80-29527 Pipeline gas from coal: Hydrogenation (IGT
Tandem mirror fusion-fission hybrid studies	hydrogasification process)
[UCBL-84018] p0754 880-33237	[FE-2434-33A] p0703 N80-31630
OLTER SALTS Internally insulated thermal storage system	Molten salt coal gasification process development unit
development program	[SAN-1429-56] p0703 N80-31631
[SAHD-80-8175] p0775 H80-28924  Molten salt coal gasification process development	Cryogenic methane separation/catalytic , hydrogasification process analysis
unit	[FB-3044-T7]
[SAH-1429-52] p0700 H80-30554  Holten salt coal gasification process development	International energy indicators [DOE/IA-0010] p0588 M80-32518
unit	BETWORK AVALYSIS
[SAN-1429-56] P0703 N80-31631 IOLTEDENUM COMPOUNDS	Simulation of a solar energy system by means of an electrical resistance network
Photoelectrochemical compatibility of n-WSe2 and	p0625 A80-51686
n-HoSe2 with various redox systems photodecomposition of semiconductor solar cell	Material-flow data structures as a basis for energy information system design
surface	[LBL-10248] p0760 E80-31923
P0610 A80-47141	HEUTRAL BEAMS  Beutral-beam energy and power requirements for
Momentum theory analysis of unconventional wind	expanding-radius and full-bore start-up of
extraction schemes, part 10 [ASRL-TR-194-2-P1-10] p0742 880-28932	tokamak reactors p0719 A80-44656
form in 124 vir ial haids 800_50335	PO 12 PO - 4000

SUBJECT INDEX HOBLIFRAR PROGRAMMING

	•
SECTRON SCATTEBING Structure of amorphous silicon and silicon hydrides p0599 A80-46647	BICERL OXIDES  Establishment of parameters for production of long life nickel oxide electrodes for nickel-hydrogen
WEW BMGLAND (US) Potential for hydropower development at existing	cells p0771 A80-48445
dams in New England Volume 1: Physical and economic findings and methodology [PB80-169121] p0578 N80-28934	BICKEL RING BATTERIES  Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells
Potential for hydropower development at existing dams in New England. Volume 2: User's manual	p0766 A80-48329 Temperature limitations of alkaline battery
[FB80-169139] p0578 B80-28935 HICKRL	electrodes p0766 A80-48330
Investigation of the characteristics of electrochemical coatings for solar-radiation collectors	Nickel-zinc batteries for aircraft and aerospace applications p0772 A80-48483
p0611 A80-47164 An advanced technology iron-nickel battery for electric vehicle propulsion	Hybrid lithium/nickel-zinc large missile ground power source p0772 A80-48489
p0766 A80-48327	Nickel-zinc batteries for RPV applications
WICKEL CADMIUM BATTERIES  Hission analysis of the P78-2 power subsystem	[AD-A088594] p0780 N80-33908 BITRATES
after one year of operation p0765 A80-48310	Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes
RCA Satcom F1 and F2 Ni-Cd battery orbital performance	p0572 A80-48534
p0769 A80-48394 The Intelsat V nickel- cadmium battery system	Closed-cycle gas turbines for power generation and LNG vaporization
p0769 A80-48395	p0739 180-52600
Aerospace nickel-cadmium/nickel-hydrogen electrode process facility	Formation and control of fuel-nitrogen pollutants in catalytic combustion of coal-derived gases
p0769 A80-48396 Application of battery reconditioning techniques	[PE-2762-8] p0577 N80-28557 NITROGEN COMPOUNDS
to achieve capacity restoration - A case history Wi-Cd cell performance improvement for	Mechanisms of nitrogen heterocycle influence on turbine fuel stability
spacecraft applications	p0695 #80-29327
p0769 A80-48397 Nickel-cadmium batteries for the Modular Power	CONVERSION OF DITTOGEN OXIDE GASES to DITTATE
Subsystem of Multimission Modular Spacecraft p0769 A80-48398	particles in oil refinery plumes p0572 A80-48534
Performance of the recently developed Ni-Cd cells for the ETS-III batteries p0769 A80-48399	Advanced combustion systems for stationary gas turbine engines. Volume 2: Bench scale evaluation
An accelerated test design for use with synchronous orbit on Ni-Cd cell degradation	[PB80-175607] p0744 M80-29922 Pilot scale combustion evaluation of waste and
behavior p0770 A80-48401	alternate fuels, phase 3 [PB80-177413] p0702 880-30952
Wew separator materials for nickel-cadmium aircraft batteries	Photochemical study of NOx removal from stack gases [PB80-181274] p0582 N80-30966
PO772 A80-48484	Determination of air pollutant emission factors for thermal tertiary oil recovery operations in
Nickel hydrogen battery for load leveling application	California, volume 1 [FB80-187594] p0585 N80-31982
p0766 A80-48328 Aerospace nickel-cadmium/nickel-hydrogen electrode process facility	Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California. Volume 2: Appendix
p0769 A80-48396	[PB80-187602] p0585 880-31983
Status of COMSAT/INTELSAT mickel-hydrogen battery technology	Performance characteristics of nonequilibrium MHD
p0770 A80-48437 Nickel-hydrogen batteries for INTELSAT V	generator with fully ionized seed and enlargement of stabilized region
p0770 A80-48438 Nickel hydrogen battery advanced development	WONEQUILIBRIUM PLASMAS p0739 A80-51465
program status report p0770 A80-48439	Instability analysis in a nonequilibrium HHD generator Thesis
Nickel hydrogen battery for a spacecraft power subsystem	p0737 A80-50357 The dispersion relation of electrothermal waves in a nonequilibrium magnetohydrodynamic plasma
Nickel-hydrogen battery integration study for the Multimission Modular Spacecraft	closed cycle magnetohydrodynamic generators [TH-78-B-92] p0744 880-30198
p0770 A80-48441 Life cycle test of Air Force nickel-hydrogen flight experiment battery	BOWFERROUS METALS Environmental protection - Cooperation versus enactments
p0771 A80-48443 Cycling characteristics of nickel-hydrogen cells	p0569 A80-43843 A method to reclaim metallic material and energy
p0771 A80-48444 Establishment of parameters for production of long	from automobiles p0684 A80-50024
life nickel oxide electrodes for nickel-hydrogen cells	BOBLIBBAR EQUATIONS  Nonlinear coupling of the slow wave structure with
p0771 A80-48445 Test data analysis and application of nickel	the lower-hybrid waves near the plasma surface
hydrogen cells	p0720 A80-45291
p0771 A80-48446 Nickel hydrogen cell development centered on	OTEC power system modeling, analysis and design
positive electrodes with high capacity per unit area for load leveling and traction applications	via geometric programming p0739 A80-52048
[BMFT-FB-T-79-74] p0776 H80-29908	

WOULINGAR SYSTEMS SUBJECT INDEX

OBLIBEAD SYSTEMS Describing-function method for estimating the	High-temperature thermochemical water splitting cycle fusion reactor design considerations
performance of a dynamic system having nonlinear-power take-off, with application to wave-power conversion	p0663 A80-48449 Present and future status of thermochemical cycles applied to fusion energy sources
p0739 A80-51464	p0663 A80-48450 High-temperature fusion blanket for a synthetic
End zone of a frame-type channel with an inhomogeneous flow current and potential	fuel plant p0663 180-48451
fields in plasma p0739 A80-52555	BUCLEAR MAGNETIC BESONANCE Investigation of mechanisms of hydrogen transfer
WHUBIFORM PLASMAS  Nonlinear coupling of the slow wave structure with	in coal hydrogenation, phase 2 [FE-2305-30] p0710 N80-32568
the lower-hybrid waves near the plasma surface in controlled fusion	NUCLEAR POWER PLANTS  Thermodynamic analysis of the helium cycles of gas
p0720 A80-45291 Instability analysis in a nonequilibrium MHD	turbine nuclear power plants p0721 A60-47080
generator Thesis'	EUCLEAR REACTORS
DUCLEAR ELECTRIC POURE GENERATION	Assessment of the US Mirror Pusion program.  Report of the 1980 Mirror Senior Review Panel [DE/SE-0057] p0748 M80-31214
The Outlook for nuclear power [PB80-175755] p0579 #80-29156	[DOE/ER-0057] p0748 M80-31214 Gasification of coal with solar energy
DOE authorization, 1981, volume 2 [GPO-61-774-VOL-2] p0581 M80-30224	[UCRL-84458] p0643 N80-31652
Climate and energy: A comparative assessment of	Porecasts of energy technology. Citations from
the Satellite Power System (SPS) and alternative energy technologies	the International Aerospace Abstracts data base [NASA-CR-163596] p0782 N80-32965
[DOE/ER-0050] p0581 N80-30914 Comparative analysis of net energy balance for	EUCLERTION Condensation processes in coal combustion products
Satellite Fower Systems (SPS) and other energy systems	[DOB/BE-10456/1] p0708 B80-32473
[DOB/ER-0056] p0582 M80-30916	Transient thermal analysis of phase change thermal
Tandem mirror fusion-fission hybrid studies [UCRL-84018] p0754 M80-33237	energy storage systems [ASME PAPER 80-HT-2] p0762 A80-48001
UCLEAR ELECTRIC PROPULSION	Comparison of use of Hottel chart and the zone
Collector temperature effects on the performance of advanced thermionic converters and nuclear	method for radiative heat transfer in our open
electric propulsion systems	cycle MED radiant boiler [ASME PAPER 80-HT-44] p0722 A80-48022
p0730 A80-48421	Sites for wind-power installations: Wind
BCLBAR REERGY DCE authorization, 1981, volume 2	characteristics over ridges, part 2 [BLO-2438-78/2] p0706 B80-31901
[GPO-61-774-VOL-2] p0581 N80-30224	NUMERICAL FLOW VISUALIZATION WIND: Computer program for calculation of three
Tandem mirror fusion-fission hybrid studies	dimensional potential compressible flow about
[UCBL-84018] p0754 M80-33237	wind turbine rotor blades [BASA-TP-1729] p0755 B80-33357
UCLEAR FUELS  High-temperature gas-cooled reactors and process heat	
UCLIAR FUELS  Bigh-temperature gas-cooled reactors and process heat  p0758 A60-48312	[ MASA-TP-1729 ] p0755 N80-33357
UCLEAR FUELS  High-temperature gas-cooled reactors and process heat	[NASA-TP-1729] p0755 N80-33357
UCLEAR FUBLS  High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program  p0677 A80-48402	[ MASA-TP-1729 ] p0755 N80-33357  OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview
UCLEAR FUELS  Bigh-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program	[ MASA-TP-1729 ] p0755 N80-33357  OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean
HIGHER PUBLS  High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle  [CONF-791185-3]  hagnetohydrodynamic generators in power	p0755 N80-33357  OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Beport of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's
BUCLEAR FUBLS  Righ-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle [COMP-791185-3]  Bagnetohydrodynamic generators in power generation. Citations from the BTIS data base	[NASA-TP-1729] p0755 N80-33357  OCEAN CUBERRYS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922
HIGHER PUBLS  High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle  [COMP-791185-3] p0698 N80-30171  Magnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856] p0748 N80-30954	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to
High-temperature gas-cooled reactors and process heat  Perspective on the DOE fusion synthetic fuels program  Po677 A80-48402  Overview of nuclear fuel cycle  [COMP-791185-3]  Magnetohydrodynamic generators in power generation. Citations from the MTIS data base [PB80-810856]  UCLEAR PUSION  Application of the fusion reactor to	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the
HIGHER PUBLS  High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle  [COMP-791185-3]  Hagnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856]  DCCLEAR PUSION	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026
High-temperature gas-cooled reactors and process heat  PO758 A60-48312  Perspective on the DOE fusion synthetic fuels program  PO677 A80-48402  Overview of nuclear fuel cycle  [COMP-791185-3]  Magnetohydrodynamic generators in power generation. Citations from the MTIS data base [PB80-810856]  PO748 N80-30954  HIGHER PUSION  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026 South Atlantic OCS physical oceanography, volume 3
HIGGLEAR FUBLS  High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle  [CONF-791185-3]  Magnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026
HIGGLEAR FUBLS  High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle  [CONF-791185-3] p0698 M80-30171  Magnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856] p0748 M80-30954  HUCLEAR FUSION  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel [DOE/ER-0057]	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities
High-temperature gas-cooled reactors and process heat  P0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  P0677 A80-48402  Overview of nuclear fuel cycle [CONF-791185-3]  Magnetohydrodynamic generators in power generation. Citations from the NTIS data base [P880-810856]  P0748 N80-30954  HOLLEAR FUSION  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel [DOB/EB-0057]  Bnergy and technology review	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [COMP-790631-1] p0701 M80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 M80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [FB80-181563] p0583 M80-31027
High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle  [CONF-791185-3]  Magnetohydrodynamic generators in power generation. Citations from the NTIS data base  [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel  [DOE/ER-0057]  Energy and technology review  [UCRL-52000-80-6]  Tandem mirror fusion-fission hybrid studies	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Beport of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [PB80-181563]  The SWAB (Spectral Wave And Bar) program [FB80-196041] p0714 N80-34052
High-temperature gas-cooled reactors and process heat  P0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  P0677 A80-48402  Overview of nuclear fuel cycle [CONF-791185-3]  Bagnetohydrodynamic generators in power generation. Citations from the BTIS data base [P880-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water  P0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel [DOB/ER-0057]  Energy and technology review [UCRL-52000-80-6]  Tandem mirror fusion-fission hybrid studies [UCRL-84018]	OCEAN CURRENTS  U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [COMP-790631-1] p0701 M80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 M80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [PB80-181563] p0583 M80-31027  The SWAB (Spectral Wave And Bar) program [FB80-196041] p0714 M80-34052  OCEAN CURRENTS
High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle  [CONF-791185-3]  Magnetohydrodynamic generators in power generation. Citations from the NTIS data base  [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel  [DOE/ER-0057]  Energy and technology review  [UCRL-52000-80-6]  Tandem mirror fusion-fission hybrid studies	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Beport of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [PB80-181563] p0583 N80-31027  The SWAB [Spectral Wave And Bar) program [FB80-196041] p0714 N80-34052  OCEAN SURPACE Feasibility of siting SPS rectennas over the sea p0623 A80-50955
High-temperature gas-cooled reactors and process heat  P0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  P0677 A80-48402  Overview of nuclear fuel cycle [CONF-791185-3]  Magnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel [DOB/ER-0057]  Rergy and technology review [UCRL-52000-80-6]  Tandem mirror fusion-fission hybrid studies [UCRL-84018]  P0754 N80-33237  Pulsed power accelerators for particle beam fusion [SAHD-80-0550C]  UCLEAR BEAT	OCEAN CUBERETS  U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [COMP-790631-1] p0701 M80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 M80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [PB80-181563] p0583 M80-31027  The SWAB (Spectral Wave And Bar) program [FB80-196041] p0714 M80-34052  OCEAE SURPACE Feasibility of siting SPS rectennas over the sea p0623 A80-50955
High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle  [CONF-791185-3]  Bagnetohydrodynamic generators in power generation. Citations from the BTIS data base  [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Pusion program.  Report of the 1980 Mirror Senior Review Panel  [DOE/ER-0057]  Energy and technology review  [UCBL-52000-80-6]  Tandem mirror fusion-fission hybrid studies  [UCBL-84018]  Pulsed power accelerators for particle beam fusion  [SAED-80-0550C]  WICLEAR REAT  Status of nuclear high temperature process heat development in the Federal Republic of Germany	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Beport of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [FB80-181563] p0583 N80-31027  The SWAB [Spectral Wave And Bar) program [FB80-196041] p0714 N80-34052  OCEAH SURPACE Peasibility of siting SPS rectennas over the sea p0623 A80-50955  OCEAH TEMPERATURE  Thermal resource availability ocean temperature data base for OTEC purposes
High-temperature gas-cooled reactors and process heat  P0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  P0677 A80-48402  Overview of nuclear fuel cycle [CONF-791185-3]  Magnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water  P0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel [DOB/ER-0057]  Energy and technology review [UCRL-52000-80-6]  Tandem mirror fusion-fission hybrid studies [UCRL-84018]  P0754 N80-33237  Pulsed power accelerators for particle beam fusion [SAED-80-0550C]  UCLEAR BRAT  Status of nuclear high temperature process heat development in the Federal Republic of Germany /coal gasification and long distance energy	OCEAN CURRENTS  U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [COBF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [PB80-181563] p0582 N80-31027  The SWAB (Spectral Wave And Bar) program [FB80-196041] p0714 N80-34052  OCEAE SURPACE Feasibility of siting SPS rectennas over the sea p0623 A80-50955  OCEAE TEMPERATURE Thermal resource availability ocean temperature data base for OTEC purposes
High-temperature gas-cooled reactors and process heat  p0758 A60-48312  Perspective on the DOE fusion synthetic fuels program  p0677 A80-48402  Overview of nuclear fuel cycle  [CONF-791185-3]  Bagnetohydrodynamic generators in power generation. Citations from the BTIS data base  [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Pusion program.  Report of the 1980 Mirror Senior Review Panel  [DOE/ER-0057]  Energy and technology review  [UCBL-52000-80-6]  Tandem mirror fusion-fission hybrid studies  [UCBL-84018]  Pulsed power accelerators for particle beam fusion  [SAED-80-0550C]  WICLEAR REAT  Status of nuclear high temperature process heat development in the Federal Republic of Germany	OCEAN CURRENTS U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Beport of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [FB80-181563] p0583 N80-31027  The SWAB [Spectral Wave And Bar) program [FB80-196041] p0714 N80-34052  OCEAH SURPACE Peasibility of siting SPS rectennas over the sea p0623 A80-50955  OCEAH TEMPERATURE  Thermal resource availability ocean temperature data base for OTEC purposes
High-temperature gas-cooled reactors and process heat  PO758 A60-48312  Perspective on the DOB fusion synthetic fuels program  PO677 A80-48402  Overview of nuclear fuel cycle [CONF-791185-3]  Bagnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Pusion program.  Report of the 1980 Mirror Senior Review Panel [DOB/RB-0057]  Energy and technology review [UCRL-52000-80-6]  Tandem mirror fusion-fission hybrid studies [UCBL-84018]  Pulsed power accelerators for particle beam fusion [SAND-80-0550C]  FUCLNAB HEAT  Status of nuclear high temperature process heat development in the Federal Republic of Germany /coal gasification and long distance energy transport/	OCEAN CUBERETS  U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONY-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities  [PB80-181563] p0583 N80-31027  The SWAB (Spectral Wave And Bar) program [PB80-186041] p0714 N80-34052  OCEAH SURPACE Peasibility of siting SPS rectennas over the sea p0623 A80-50955  OCEAH TEMPREATURE  Thermal resource availability ocean temperature data base for OTEC purposes p0718 A80-44603
High-temperature gas-cooled reactors and process heat  P0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  P0677 A80-48402  Overview of nuclear fuel cycle [CONF-791185-3]  Magnetohydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel [DOB/ER-0057]  Rergy and technology review [UCRL-52000-80-6]  Tandem mirror fusion-fission hybrid studies [UCRL-84018]  P0758 A80-33237  Pulsed power accelerators for particle beam fusion [SAHD-80-0550C]  UCLEAR BEAT  Status of nuclear high temperature process heat development in the Federal Republic of Germany /coal gasification and long distance energy transport/  P0758 A80-48311  High-temperature gas-cooled Feactors and process	OCEAN CUBERETS  U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [COMP-790631-1] p0701 M80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 M80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [PB80-181563] p0582 M80-31027  The SWAB (Spectral Wave And Bar) program [FB80-196041] p0714 M80-34052  OCEAN THERMAL ENERGY CONVERSION OCEAN THE THERMAL ENERGY CONVERSION OCEAN T
High-temperature gas-cooled reactors and process heat  P0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  P0677 A80-48402  Overview of nuclear fuel cycle [CONF-791185-3]  Bagnetohydrodynamic generators in power generation. Citations from the BTIS data base [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Pusion program.  Report of the 1980 Mirror Senior Review Panel [DOB/RB-0057]  Energy and technology review [UCRL-52000-80-6] p0788 880-32909  Tandem mirror fusion-fission hybrid studies [UCBL-84018] p0754 880-33237  Pulsed power accelerators for particle beam fusion [SAND-80-0550C] p0715 880-34239  UCLRAB ERAT Status of nuclear high temperature process heat development in the Federal Republic of Germany /coal gasification and long distance energy transport/  P0758 A80-48311  Bigh-temperature gas-cooled reactors and process heat	OCEAN CUBERETS  U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONY-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities  [PB80-181563] p0583 N80-31027  The SWAB (Spectral Wave And Bar) program [PB80-181563] p0714 N80-34052  OCEAN THERMACE  Feasibility of siting SPS rectennas over the sea p0623 A80-50955  OCEAN TEMPBRATUEE  Thermal resource availability ocean temperature data base for OTEC purposes p0718 A80-44603  OCEAN THERMAL EMERGY COMMERSION OCEAN THERMAL EMERGY COMMERSION P0718 A80-44509  OTEC research in Japan p0718 A80-44600
High-temperature gas-cooled reactors and process heat  P0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  P0677 A80-48402  Overview of nuclear fuel cycle [CONF-791185-3]  Bagnetohydrodynamic generators in power generation. Citations from the BTIS data base [PB80-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water  P0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel [DOB/ER-0057]  Benergy and technology review [UCBL-52000-80-6]  Tandem mirror fusion-fission hybrid studies [UCBL-84018]  P0758 A80-33237  Pulsed power accelerators for particle beam fusion [SAND-80-0550C]  P0715 N80-34239  UCLIRA BEAT  Status of nuclear high temperature process heat development in the Federal Republic of Germany /coal gasification and long distance energy transport/  High-temperature gas-cooled reactors and process heat  P0758 A80-48311  Design of the ETGR for process heat applications P0758 A80-48313  The fusion-synfuel tie producing hydrogen with the Tandem Mirror Reactor	OCEAN CUBERETS  U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [COBF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2 monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555] p0582 N80-31026  South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [PB80-181563] p0583 N80-31027  The SWAB (Spectral Wave And Bar) program [PB80-196041] p0714 N80-34052  OCEAN THERMAL ENERGY CONVERSION p0718 A80-44603  Westinghouse OTEC power systems p0718 A80-44601
High-temperature gas-cooled reactors and process heat  P0758 A60-48312  Perspective on the DOB fusion synthetic fuels program  P0677 A80-48402  Overview of nuclear fuel cycle [COBY-791185-3]  Bagnetohydrodynamic generators in power generation. Citations from the HTIS data base [P880-810856]  Application of the fusion reactor to thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water p0664 A80-51460  Assessment of the US Mirror Fusion program.  Report of the 1980 Mirror Senior Review Panel [DOB/RB-0057]  Bnergy and technology review [UCRL-52000-80-6] Tandem mirror fusion-fission hybrid studies [UCRL-84018] Pulsed power accelerators for particle beam fusion (SABD-80-0550C)  UCLEAR HRAT  Status of nuclear high temperature process heat development in the Federal Republic of Germany /coal gasification and long distance energy transport/  P0758 A80-48311  High-temperature gas-cooled reactors and process heat  p0758 A80-48312  Design of the HTGR for process heat applications p0758 A80-48313  The fusion-synfuel tie producing hydrogen with the	CCEAN CURRENTS  U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678  Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922  South Atlantic OCS physical oceanography, volume 2  monitoring ocean currents and sea states to assess effects of oil and gas activities on the environment [FB80-181555]  South Atlantic OCS physical oceanography, volume 3  monitoring ocean currents and sea states to assess the environment effects of oil and gas activities [PB80-181563]  The SWAB (Spectral Wave And Bar) program [FB80-196041]  OCEAH SURPACE Feasibility of siting SPS rectennas over the sea p0623 A80-50955  OCEAH TEMPRENTUEE  Thermal resource availability ocean temperature data base for OTEC purposes p0718 A80-44603  OCEAN THERMAL EMERGY COMMERSION 0TEC research in Japan p0718 A80-44600  Westinghouse OTEC power systems

SUBJECT IEDRY OIL RECOVERY

An update of OTEC baseline design costs	Ocean wave power available to submerged energy
p0718 A80-44604	devices of finite dimensions
Modelling the competitiveness of first generation	p0689 A80-53681
commercial OTEC power plants	Ocean energy systems: Multiyear program plan
p0718 A80-44605	[DOE/CS-0161] p0707 N80-31946
Issues in OTEC commercialization p0719 A80-44606	The use of computer-controlled manipulators in
Introducing OTEC to mainland utilities	Underwater technology
p0719 A80-44607	[DFVLR-HITT-78-02] p0714 N80-34117 OFFSHORE PLATFORMS
Review of mini-OTEC performance	Design of 40-MW grazing and moored OTEC
p0727 A80-48347	pilot/demonstration plants
Design of 40-MW grazing and moored OTEC	p0727 A80-48348
pilot/demonstration plants	The commercial application of an OTEC Jacket
p0727 A80-48348	/tower/ design
Projected costs for electricity and products from	p0728 A80-48350
OTEC facilities and plantships	Wave drift forces on OTEC platforms
p0728 A80-48349	p0740 A80-53676
The connercial application of an OTEC Jacket	Ocean engineering developments for OTEC 10/40 MW
/tower/ design	spar platforms
p0728 A80-48350	p0740 A80-53686
Material evaluation and testing program for OTEC riser cable	OTEC cold water pipe design for problems caused by
p0728 A80-48351	vortex-excited oscillations [AD-A084555] p0741 N80-28867
Thermoelectric OTEC - An update design analysis	Solar power satellite offshore rectenna study
p0731 A80-48436	[NASA-CR-161543] p0759 N80-30891
Ocean thermal energy conversion contribution to	Design study and economic assessment of multi-unit
the energy needs of the United States	offshore wind energy conversion systems
p0737 A80-50909	application. Volume 1: Executive summary
On the selection of working fluids for OTEC power	[WASH-2330-78/4-VOL-1] p0746 N80-30930
plants	South Atlantic OCS physical oceanography, volume 2
p0738 180-50946	monitoring ocean currents and sea states to
OTEC power system modeling, analysis and design	assess effects of oil and gas activities on the
via geometric programming	environment
p0739 A80-52048	[ PB80-181555] p0582 N80-31026
Mini-OTEC . p0740 A80-53473	South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to
Ocean thermal energy conversion /OTEC/ - A	assess the environment effects of oil and gas
subscale test range	activities
p0740 A80-53674	[PB80-181563] p0583 N80-31027
Kelp farm and OTEC-1 upwelling pipes	A quantitative evaluation of closed-cycle ocean
p0740 A80-53675	thermal energy conversion (OTEC) technology in
Wave drift forces on OTBC platforms	central station applications
p0740 A80-53676	[B-2595-DOE] p0749 N80-31885
U.S. Department of Energy ocean waves and ocean	CHRIC DISSIPATION
currents energy conversion programs - An overview	Joule heating effects in the electrode wall
p0740 A80-53678 The Cold Water Pipe - Ocean engineering status and	boundary layer of MHD generators p0743 N80-29620
developments	OIL EXPLORATION
p0740 A80-53684	Landsat imagery is oil exploration - Six years of
Ocean engineering developments for OTEC 10/40 MW	experience
spar platforms	p0685 A80-50880
p0740 A80-53686	Application of remote sensing techniques to
Environmental concerns for OTEC identified in the	petroleum exploration in India
DOE OTEC Environmental Readiness Document	р0686 д80-51088
p0576 A80-53687	South Atlantic OCS physical oceanography, volume 2
Optimum OTEC design and sensitivity analysis using geometric programming	monitoring ocean currents and sea states to
p0741 A80-53688	assess effects of oil and gas activities on the environment
1979 status of the OTEC Environment Program	[PB80-181555] p0582 N80-31026
p0577 180-53689	South Atlantic OCS physical oceanography, volume 3
OTEC cold water pipe design for problems caused by	monitoring ocean currents and sea states to
vortex-excited oscillations	assess the environment effects of oil and gas
[AD-A084555] p0741 N80-28667	activities
A quantitative evaluation of closed-cycle ocean	[PB80-181563] p0583 N80-31027
thermal energy conversion (OTEC) technology in	International energy indicators
central station applications	[DOE/IA-0010] p0588 N80-32918
[R-2595-DOE] p0749 M80-31885 Continued evaluation of compact heat exchangers	OIL PIELDS
for OTEC evaluation	Recent activity in U.S. tar sand p0671 A80-48166
[COU-4238-14] p0750 N80-31945	Tar sands and heavy oil reservoir evaluation using
Proceedings of the Ocean Energy Information	geophysical well logs
Dissemination Workshop	p0671 A80-48167
[SERI/TP-732-600] p0753 N80-32956	International energy indicators
OCEA HOGRAPHY	[DOE/IA-0001T/3(80)] p0781 N80-28919
Report of the 6th Ocean Thermal Energy Conversion	Economics of shale oil production by radio
Conference. Ocean Thermal Energy for the 1980's	frequency heating
[CONF-790631-1] p0701 N80-30922	[UCBL-52942] p0710 N80-32566
OFF-OB CONTROL	OIL POLLUTION
Evaluation of control strategies for solar	The fate and effects of crude oil spilled on
collector loops [LBL-10716] p0647 880-31932	subarctic permafrost terrain in interior Alaska [FB80-187305] p0585 N80-31984
OFFSHORE ENERGY SOURCES	OIL RECOVERY
Power extraction from deep ocean waves employing a	Processing of coal, oil sand and heavy oil in situ
novel wave energy device	by electric and magnetic fields
[ASHE PAPER 80-PET-29] p0720 A80-45275	p0669 A80-44846
Ocean thermal energy conversion /OTEC/ - A	Heat and mass transfer processes during the
subscale test range	pyrolysis of antrim oil shale
p0740 180-53674	[ASBE PAPER 80-HT-123] p0671 A80-48039

Recent activity in U.S. tar sand	OPTICS
p0671 A80-48166	Fundamentals and techniques of nonimaging optics
Solaroil project. Phase 1: Preliminary design report	for solar energy concentration [DOE/RE-04657/2] p0652 M80-32896
[GA-A-15823] p0633 H80-29505 Field experiences with rotordynamic instability in	Volume optimization of sodium-sulfur batteries
high-performance turbomachinery oil and natural gas recovery	using various advanced cell concepts p0764 A80-48236
p0697 N80-29707	OPTIONS
Determination of air pollutant emission factors	SPS salvage and disposal alternatives
for thermal tertiary oil recovery operations in	[NASA~CR-161548] p0641 N80-30898
California, volume 1 [PB80-187594] p0585 N80-31982	ORBIT TRANSPER VEHICLES  Electric propulsion for SPS
Determination of air pollutant emission factors	p0643 N80-31466
for thermal tertiary oil recovery operations in	ORBITAL ASSEMBLY
California. Volume 2: Appendix	Satellite Power Systems (SPS) concept definition study. Volume 5: Special emphasis studies
[PB 80-187602] p0585 N80-31983	rectenna and solar power satellite design studies
Near term commercialization of MED power generation using coal/oil fuel	[NASA-CB-3322] p0651 N80-32861 ORBITAL SPACE STATIONS
p0724 A80-48225 Waste oil as a fuel	Power management for multi-100 KWe space systems p0758 A80-48357
p0684 A80-50032	ORGANIC CERNISTRY
DE DIMERSIONAL PLOW	Organic photochemical storage of solar energy
One-dimensional model for pulverized coal	[COO-4380-3] p0632 N80-28905
combustion and gasification p0669 A80-45322	ORGINIC COMPOUNDS  Han-made molecular assemblies for energy
Numerical simulation of dual-media thermal energy	conversion from light into chemical potentials
storage systems	p0661 A80-46271
[ASHE PAPER 79-HT-35] p0761 A80-45725	Recycling of effluents and organic residues into
Haximum windmill efficiency p0737 A80-50721	methane by anaerobic digestion - New perspectives p0683 A80-49995
Mixing and gasification of coal in entrained flow	Development of unique catalysts for
systems. Volume 2: User's manual for a	hydrodenitrogenation of coal-derived liquids
computer program for 1-dimensional coal combustion or gasification (1-DICOG)	anilines [FE-3297-2] p0690 H80-28545
[FE-2666-F-VOL-2] p0706 N80-31656	Organic material emissions from holding ponds at
Coal processing for fuel cell utilization: Task	coal-fired power generation facilities
9: One-dimensional (streamtube) model for	[EPRI-BA-1377] p0589 880-32987
entrained-flow gasifier analysis [METC-8450-T2-VOL-1] p0707 N80-31912	ORGANIC MATERIALS Semiconductor-electrolyte solar cells for the
DETARIO	photoelectrochemical reduction of carbon dioxide
Potential for conversion of refuse to energy in	to organic fuel
Ontario Canada and the Provincial Energy from Waste program	P0605 A80-46755 ORGANIC WASTES (FUEL CONTRESION)
p0681 A80-49946	Development of a methane fermentation process for
PERATIONAL PEOBLEMS	organic wastes
An environmental assessment of the satellite power	p0679 A80-49545
system reference design p0757 A80-46396	Combustible briquets from waste using the PINEDA/LOAS process
Operational experience with a saturated borax	p0683 180-50009
solar pond	Refuse to fuels - An appraisal of thermal processes
PO617 A80-48365 PPERATIONS RESEARCH	p0684 A80-50011
Survey of world coal energy studies and	Reduction of fuel consumption by thermodynamic
international coal mining research	optimization of the Otto motor: Comparative
[FE-2468-68] p0691 N80-28551	investigation of Otto diesel engines
Basic Research in Engineering: Process and Systems Dynamics and Control. High Priority	[EUR-6711-DE] 'p0585 N80-32733
Research Needs Relevant to Energy	One-dimensional model for pulverized coal
[FE-2468-65] p0590 N80-33167	combustion and gasification
OPTICAL DEBSITY Generalization of the two-dimensional optical	p0669 A80-45322 Aqueous trifluoromethanesulfonic acid fuel cells
analysis of cylindrical concentrators	[AD-A086579] p0745 N80-30905
p0599 A80-46566	Materials for fuel cells
OPTICAL EQUIPMENT  Irradiance on the receiver of a general optical	[PB80-182355] p0748 B80-30955 Oxidation of electrodeposited black chrome
concentrator	selective solar absorber films
p0610 A80-47043	[SAND-80-1045C] p0656 N80-32953
OPTICAL FILTRES	OXIDATION-REDUCTION REACTIONS
Operation of multi-bandgap concentrator cells with a spectrum splitting filter photovoltaic	Ban-made molecular assemblies for energy conversion from light into chemical potentials
conversion efficiency	p0661 A80-46271
p0604 A80-46740	Photoelectrochemical compatibility of n-WSe2 and
Prical Brasument  Pulsed measurement of solar cell spectral response	n-MoSe2 with various redox systems photodecomposition of semiconductor solar cell
p0604 A80-46737	surface .
DPTICAL BEFLECTION	p0610 A80-47141
Advanced thin silicon solar cell with controlled	OXIDE FILMS
optical absorptance for space power systems and arrays	Oxide/semiconductor photovoltaic heterojunctions based on CdTe or InP
p0601 A80-46710	p0603 A80-46732
General formula for the incidence factor of a	Preparation and analysis of Cu20 thin-file solar
solar heliostat receiver system p0622 A80-49758	cells p0607 A80-46781
Optical analysis of point focus parabolic	On the influence of an interfacial oxide layer on
radiation concentrators	Au/n-Gals Schottky barrier solar cells
[SERI/TR-631-336] p0646 R80-31917	p0608 A80-46784

	Solar selective black cobalt - Prepar structure, and thermal stability		Thermal buffering of receivers for p solar thermal power plants	arabol	ic dish
		p0609 A80-46933			A80-48419
X	<b>TGBN</b> Oxygen electrodes for energy conversi		Long-term average performance benefi parabolic trough improvements		
X	IGES PRODUCTION	p0753 #80-32878	[SERI/TR-632-439] PARALLEL PLATES	•	N80-28893
	Bydrogen and oxygen from water. III - of a hybrid process		Tests of a lightweight 200 kW MHD ch diffuser	annel	and
	Simultaneous photogroduction of hydro	p0661 A80-45298 ogen and	[AD-A087022] PARAMETER IDENTIFICATION	p0751	№80-32226
	<pre>oxygen by photosynthesis to con energy into stored chemical free en [CONP-791072-32]</pre>		Solar Central Receiver Hybrid Power sodium-cooled receiver concept. V 1: Conceptual design, sections 1	olume :	2, book
	P	•	[DOE/ET-20567/1-2-BK-1] PARTIAL PRESSURB		N80-31896
<u>-</u> -1	I-B JUBCTIONS	•	Aqueous trifluoromethanesulfonic aci [AD-A086579]		cells N80-30905
	Optimization studies of materials in amorphous silicon solar cells		PARTICLE ACCELERATORS Pulsed power accelerators for partic	le bea	m fusion
? <b>-</b> 1	N JUNCTIONS	p0602. A80-46717.	[SAND-80-0550C] PARTICLE BEAMS	p0715	N80-34239
	A multiple p-n junction structure obt as-grown Czochralski silicon crysta treatment - Application to solar ce	als by heat ells	Pulsed power accelerators for partic [SAND-80-0550C] PARTICLE SIZE DISTRIBUTION		m fusion N80-34239
	Experimental optimization of the effi		Coal processing for fuel cell utiliz 9: One-dimensional (streamtube) m		
	n/+/-p-p/+/ and p/+/-n-n/+/ silicon Survey of semiconductor combinations	p0601 A80-46706	entrained-flow gasifier analysis [METC-8450-T2-VOL-1] PARTICLE TRAJECTORIES	p0707	N80-31912
	heterojunction thin film solar cell		Theoretical multiple beam overlap fr transport of intense particle beam		nnel
	Some electric and photoelectric proper photodetectors based on epitaxial.		PARTICLES		A80-49067
	Si/x/Ge/1-x/ with diffused p-n junc	tion . p0610 A80-47153	Advanced synfuels production/power s utilizing laser particulate contro	1	
P-:	TYPE SENICONDUCTORS			p0710	N80-32570
	Semiconductor-electrolyte solar cells photoelectrochemical reduction of c to organic fuel	carbon dioxide	PARTICULATE SAMPLING A study of the gaseous and particula in the environment of a thermal po		
	On the effects of boron and phosphoru impurities in p-type silicon materi		project area PATENT POLICY	p0570	A80-46150
	cells	p0606 A80-46758	Patent profiles: Solar energy	p0649	N80-31966
	Photo-intercalation - Possible applic solar energy devices	p0620 A80-48548	PRAT  Feasibility of a peat biogasification		ess A80-46197
	Photoelectrochemistry with p-Si elect Effects of inversion	trodes -	Peat and wood as fuels - Another for energy utilization	n of s	olar
	Hydrogen production by photoelectroly decomposition of H2O using solar en		Status of peat biogasification devel	opment	A80-47595 A80-48293
PAI	[NASA-CR-163586] PBB (HATERIAL)	p0667 N80-32854	Peat char gasification - Laboratory studies Process Development Un	and PD	U-scale
PAI	Solar gasification of charcoal, wood [UCRL-84411] RABOLIC BODIES	p0654 N80-32926	Liquid products from peat pyrolysis	• .	A80-48294 A80-48385
		notovoltaics p0606 A80-46791	Peat as a fuel at the proposed Centr Power Company 600 MW plant, volume	al Mar:	ine
· Al	RABOLIC REFLECTORS Analysis of the influence of geograph		[ PB80-175185] PELLETS	-	N80-29524
·	on parabolic trough solar collector [SAND-79-2032] Long-term average performance benefit	p0631 N80-28876	The feasibility of pellet re-fuellin reactor		10510A A80-44661
	parabolic trough improvements	p0632 N80-28893	PERFORMANCE Standard procedures for terrestrial	,	
	Optical analysis of point focus parab radiation concentrators	bolic	performance measurements: Specifi [BUR-6423BN]	cation	
	[SEEI/TE-631-336] Dual curvature acoustically damped co collector	p0646 M80-31917 oncentrating	PERFORMANCE PREDICTION  Physical/chemical modeling for photo life prediction	<b>v</b> oltai	c module
	[DOE/C5-34196/T1] Hean wind forces on parabolic-trough collectors	p0647 N80-31921 solar	Optimization studies of lithium/iron for electric vehicle applications		A80-46790 de cells
	Parabolic trough solar collector wind [SAND-79-2134C]	p0652 N80-32895	Generalized performance predictions conversion plants using geopressur	for ene	
	The 3% Compound Parabolic Concentrati solar energy collector [DOE/CS-04239/T1]	ng (CPC) p0655 N80-32944	fluids  Benefits arising from the use of pne		A80-48268 energy
À	AABOLOID BIBBORS The JFL parabolic dish project so	_	transmittal in wind-power systems		A80-48271
	. collectors technology development	p0618 A80-48417	Implications of the effects of wind characteristics on the operation o turbines	_	
	solar thermal power plants	p0618 A80-48418		p0727	A80-48321
		•		p0727	A80-48322

PERFORMANCE TESTS SUBJECT INDEX

Performance of the recently developed Ni-Cd cells for the ETS-III batteries Performance and structural characteristics of the iron-air battery system --- for electric vehicle p0769 A80-48399 Cycling characteristics of nickel-hydrogen cells p0771 A80-48444 Establishment of parameters for production of long Harmonic analysis of Stirling engine thermodynamics p0730 A80-48408 Collector temperature effects on the performance life nickel oxide electrodes for nickel-hydrogen of advanced thermionic converters and nuclear p0771 A80-48445
Test data analysis and application of nickel electric propulsion systems p0730 A80-48421 A state space analysis of a symmetrical compounded hydrogen cells p0771 A80-48446 free piston Stirling engine One megawatt /thermal/ bench model solar receiver design and test p0734 A80-48498 Hodal analysis of miniature cryogenic coolers P0734 A80-48500 p0619 A80-48464 A stochastic model for predicting solar system performance --- for water heating New separator materials for nickel-cadmium aircraft batteries p0621 A80-48921 D0772 A80-48484 A design method for parallel solar-heat pump systems p0621 A80-48922 Small windmills in Denmark p0735 A80-48525 The effect of direct and diffuse radiations on the thermal performance of flat-plate solar collectors Transient thermal behaviour of solar ponds p0623 A80-50962 Degradation of solar cell performance by areal p0620 A80-48793 inhomogeneity Vehicles testing of near-term batteries [SAE PAPER 800201] p07 P0773 A80-49730 p0624 A80-51112 Evaluation of high temperature LiAl/TiS2 cells p0773 A80-50508 Predicted effect of grid line aspect ratio on the performance of solar cells p0625 A80-51687 Wind tunnel tests on a 3 m diameter Musgrove Predicting passive solar performance using modal expansions p0737 A80-50943 p0627 A80-52836 Performance of a low cost cross-wind-axis sail-wind turbine A semi-empirical method for estimating the performance of direct gain passive solar heated buildings Ammonia/water absorption cycles with relatively p0627 A80-52838 high generator temperatures D0625 A80-51682 Manual and programmable calculator methods for sizing solar energy systems [BPRI-BR-1282-SR] Cost and thermal performance comparisons for wall p0632 N80-28890 systems as applied to passive solar building p0628 A80-52842
Advanced combustion systems for stationary gas
turbine engines. Volume 4: Combustor
verification Reporting format for thermal performance of solar heating and cooling systems in buildings [PB80-175375] p0634 N80-295 p0634 N80-29537 verification testing, addendum Solar energy system performance evaluation. Seasonal report for Colt Pueblo, Pueblo, Colorado [NASA-CR-161493] p0635 880-29850 [PB80-179849] p0698 #80-30313 Development of high-temperature turbine subsystem technology to a technology readiness status, Performance estimates for attached sunspace passive solar heated buildings
[LA-UR-80-853] p064:
Optical analysis of point focus parabolic phase 2 [FE-1806-86] p0701 N80-30753 D0642 B80-30913 Hydrogen engine performance analysis project p0665 N80-30756 [SAN-1212-T1] radiation concentrators [SERI/TR-631-336] Sencenbaugh: Model 1000-14 wind turbine generator [RFP-3034/3533/79-5] p0746 R80-30931 p0646 B80-31917 [RFF-3034/3533/79-5] p0746 i Performance data for a lithium-silicon/iron Continued evaluation of compact heat exchangers for OTEC evaluation [COO-4238-14] p0750 N80-31945 disulfide, long-life, primary thermal battery [SAND-79-2148C] p0746 N80-30933 Modeling and evaluation of designs for solid hydrogen storage beds HED high performance demonstration experiment [FE-2895-7] p0751 H8 [COMP-800616-8] p0666 N80-32554 p0751 N80-32231 Upgraded automotive gas turbine engine design and development program, volume 2
[NASA-CR-159671] p0751 N80-32 PERFORMANCE TESTS Pluorescent planar concentrators - Performance and experimental results --- solar collector absorbing diffuse and direct radiation via fluorescent molecules p0751 N80-32719 UTRC 8 kW wind turbine tests [RFP-3085] D0752 N80-32722 p0604 A80-46741 Preliminary results from the shrouded wind-turbine PERMAPROST The fate and effects of crude oil spilled on pilot plant subarctic permafrost terrain in interior Alaska [PB80-187305] p0585 N80-31984 p0722 A80-47525 Cycle life studies of LiAl/PeS cells using BN felt PEROVSKITES separators The layer perovskites as thermal energy storage p0763 A80-48189 Scaling up of bipolar lithium/iron disulfide cells systems p0761 A80-45315 p0763 A80-48193 The development of thermal energy storage systems exploiting solid-solid phase transitions Results from the Hoe Creek No. 3 underground coal p0774 A80-50970 qasification experiment p0675 A80-48340 PERU Assessment of Peruvian biofuel resources and A successful eastern in situ coal gasification field trial alternatives [ANL/BES/TH-86] p0675 A80-48342 p0708 N80-32547 PETROLEUM PRODUCTS Review of mini-OTEC performance Puture aviation fuels - The petroleum industry P0727 A80-48347 responds to the challenge [SAE PAPER 800769] Material evaluation and testing program for OTEC riser cable D0680 A80-49713 D0728 A80-48351 PHASE DIAGRAMS RCA Satcom F1 and F2 Ni-Cd battery orbital Thermoelectricity - Phase diagrams and performance imperfection structures. II p0769 A80-48394 p0731 A80-48434 Application of battery reconditioning techniques to achieve capacity restoration - A case history --- Bi-Cd cell performance improvement for spacecraft applications PHASE TRANSFORMATIONS Transient response of a latent heat storage unit An analytical and experimental investigation
[ASME PAPER 79-HT-36] p0761 A80-45726

p0769 A80-48397

SUBJECT INDEX PROTOSINTERSIS

,	· ·
Managinah thomas analysis of whose shapes thomas	NUAMADY BARDIATES
Transient thermal analysis of phase change thermal energy storage systems	PHOTOBLECTRICITY Photovoltaic institutional issues study
[ASHE PAPER 80-HT-2] p0762 A80-48001	[SAND-79-7054] p0584 N80-31950
Thermal energy storage using Glauber's salt -	PHOTOELECTROCHEMICAL DEVICES
Improved storage capacity with thermal cycling	Photoelectrochemical conversion using
p0764 A80-48197 Thermoelectricity - Phase diagrams and	reaction-centre electrodes
imperfection structures. II	Solar energy conversion using CdSe
p0731 A80-48434	photoelectrochemical cells with low cost
Heat storage capability of a rolling cylinder	substrates
using Glauber's salt	p0597 A80-46253
p0773 180-50945 The development of thermal energy storage systems	Oxide semiconductors in photoelectrochemical conversion of solar energy
exploiting solid-solid phase transitions	p0599 A80-46568
p0774 A80-50970	Photoelectrochemical solar cells
Thermal energy storage using saturated salt	p0603 A80-46730
solutions p0774 A80-51125	Semiconductor-electrolyte solar cells for the photoelectrochemical reduction of carbon dioxide
- PHOSPHORIC ACID	to organic fuel
Peasibility study for industrial cogeneration fuel	p0605 A80-46755
cell application	Photoelectrochemical compatibility of n-WSe2 and
[SAN-1889-T1] p0746 N80-30934 Cell module and fuel conditioner	n-HoSe2 with warious redox systems photodecomposition of semiconductor solar cell
[NASA-CR-159888] p0749 N80-31882	surface
Development of an energy consumption and cost data	p0610 A80-47141
base for fuel cell total energy systems and	Photo-intercalation - Possible application in
conventional building energy systems [ORNL/CON-38] p0754 N80-32960	solar energy devices
[ORNL/CON-38] p0754 N80-32960 PROSPHORUS	p0620 A80-48548 Photoreduction of carbon dioxide and water into
On the effects of boron and phosphorus primary	formaldehyde and methanol on semiconductor
impurities in p-type silicon material for solar	materials
cells	p0621 A80-48923
p0606 A80-46758 Improvement of phosphorus diffused silicon solar	Photoelectrochemistry with p-Si electrodes - Effects of inversion
cells by laser treatment	p0737 180-50760
p0606 A80-46763	Visible light response of polycrystalline TiO2
PHOTOCHERICAL REACTIONS	electrodes for solar energy conversion
Conversion of carbohydrate into hydrogen fuel by a	p0664 A80-51691 Biological solar cell
photocatalytic process p0661 180-44598	[SERI/TP-623-656] p0639 H80-29893
Structures, reduction potentials and absorption	Basic research needs and priorities in solar
maxima of synthetic dyes of interest in	energy. Volume 2: Technology crosscuts for DOP
photochemical solar-energy storage studies	[SERI/TE-351-358-VOL-2] p0645 N80-31899
p0595 A80-45314 Solar energy utilization by carbanion photolysis	PHOTOGEOLOGY  Landsat imagery in oil exploration - Six years of
p0625 A80-51680	experience
Organic photochemical storage of solar energy	p0685 A80-50880
[COO-4380-3] p0632 N80-28905	Application of remote sensing techniques to
Photochemical study of NOx removal from stack gases [PB80-181274] p0582 N80-30966	petroleum exploration in India p0686 A80-51088
PHOTODIODES PROTODIODES	PHOTOISTERPRETATION
New experimental evidence for minority carrier MIS	Remote sensing and mineral exploration;
diodes for solar cells	Proceedings of the Workshop, Bangalore, India,
PHOTOBLECTRIC CRLLS	may 29-June 9, 1979 p0686 A80-51076
A computer model for polycrystalline Si n/plus//p	PHOTOLYSIS
solar cells	Utilization of solar radiation for water photolysis
p0606 180-46766	p0661 A80-47667
Design of a thermophotocell p0610 A80-47154	Biophotolytic H2 production using alginate-immobilized chloroplasts, enzymes and
Photoelectrochemistry with p-Si electrodes -	synthetic catalysts
Effects of inversion	p0664 A80-50247
p0737 A80-50760	Solar energy utilization by carbanion photolysis
Field experience with solar concentrating collector control systems	p0625 A80-51680 Solar energy conversion through biophotolysis
[SAND-79-2044C] p0647 N80-31924	[SAN-0034-239-1-T2] p0666 N80-31927
PHOTOBLECTRIC BFFECT	PHOTORAPPING
Models for the photoelectrolytic decomposition of	Landsat imagery in oil exploration - Six years of
water at semiconducting cxide anodes p0664 A80-50512	experience p0685 A80-50880
PHOTOBLECTRIC BHISSION	PHOTOMETERS
Photoelectrochemical conversion using	Some electric and photoelectric properties of
reaction-centre electrodes	photodetectors based on epitaxial layers
p0596 A80-45504 PHOTOBLECTRIC GENERATORS	Si/x/Ge/1-x/ with diffused p-n junction p0610 A80-47153
Solar energy system economic evaluation final	PHOTOSBUSITIVITY
report for SEMCO-Loxabatchee, Loxabatchee	Theoretical investigations into collection
National Wildlife refuge, Palm Beach County, Plorida	coefficient for Cu/2-x/S-CdS cells with allowance for surface states at interface
[HASA-CR-161512] p0641 H80-30894	p0610 180-47151
Potential for supplying solar thermal energy to	PHOTOSYNTHESIS
industrial unit operations	Photoelectrochemical conversion using
[SERI/TP-632-584] p0588 N80-32911	reaction-centre electrodes
The 31 Compound Parabolic Concentrating (CPC) solar energy collector	p0596 A80-45504 · Man-made molecular assemblies for energy
[DOB/CS-04239/T1] p0655 N80-32944	conversion from light into chemical potentials
Solar heating system at Quitman County Bank,	p0661 180-46271
Marks, Mississippi [NASA-CR-161549] p0657 N80-33858	Photoelectrochemical solar cells p0603 A80-46730
[ MA SA-CR-161549] p0657 M80-33858	

Biophotolytic H2 production using	
alginate-immobilized chloroplasts, synthetic catalysts	enzymes and
sinchesto catalists	p0664 A80-50247
Biological solar cell	
[SBBI/TP-623-656] Simultaneous photoproduction of hydro	p0639 #80-29893
orvgen by photosynthesis to con	vert solar
energy into stored chemical free er	ergy
[COMP-791072-32]	p0665 B80-30550
PHOTOTHERMAL CONVERSION Solar-powered Rankine engine assists	air
conditioning systems with electrica	
capability	-0611 100-07506
Photocell heat engine solar power sys	p0611 A80-47596
	p0612 A80-48179
Chemical Energy Storage for Solar The	rmal Blectric
Conversion	p0763 A80-48195
High performance photovoltaic systems	
	p0616 A80-48233
Solar thermal electric power systems	p0620 A80-48916
Ammonia/water absorption cycles with	
high generator temperatures	.0625 100 54602
Alternative configurations for sodium	p0625 A80-51682
thermal power plants	
Unbaid Abassa Labatamalkaia austasa	p0625 A80-52075
Hybrid thermal-photovoltaic systems	p0628 A80-52865
DOE solar thermal power systems progr	a.m
Pluid selection for a 100 MW/e/ line	p0629 A80-52869
central power station	TOCUS SUIAL
	p0630 A80-53572
Development of high temperature resis absorber surfaces	stant, solar
[BMFT-FB-T-79-70]	p0640 N80-29906
Utility views on solar thermal centra	
[SAND-80-8203]	P0642 B80-30911
[SAND-80-8203] Regenerative energy sources for the p	p0642 N80-30911 production of
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resul	p0642 N80-30911 production of es, energy ts and
[SAND-80-8203] Regenerative energy sources for the plant temperature heat: Energy sourcetypes, and energy conversion; resulting applications; measures to promote the second seco	p0642 N80-30911 production of es, energy ts and use
[SAND-80-8203]  Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulapplications; measures to promote to [ISBN-3-7041-0038-2]	p0642 N80-30911 production of es, energy is and ise p0702 N80-30951
[SAND-80-8203] Regenerative energy sources for the plant temperature heat: Energy sources for the property sources, and energy conversion; results applications; measures to promote to [ISBM-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 production of es, energy ts and se p0702 #80-30951 s demonstration wton systems
[SAND-80-8203] Regenerative energy sources for the plant temperature heat: Energy sources for the property sources, and energy conversion; results applications; measures to promote to [ISBM-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 production of es, energy ts and se p0702 #80-30951 s demonstration wton systems
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulapplications; measures to promote to [ISBM-3-7041-0038-2] Small solar electric system component	p0642 #80-30911 production of es, energy ts and se p0702 #80-30951 s demonstration wton systems
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy sources for the plow temperature heat: Energy sources types, and energy conversion; resultipes, and energy conversion; resultipes, and energy sources to promote to [ISBN-3-7041-0038-2] Small solar electric system component thermal storage modules for Bra [NASA-CR-163513] Thermal energy storage for solar thermal polications program [SAND-80-8218]	p0642 #80-30911 production of es, energy ts and se p0702 #80-30951 s demonstration wton systems
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulapplications; measures to promote u [ISBM-3-7041-0038-2] Small solar electric system component thermal storage modules for Brace [NASA-CR-163513] Thermal energy storage for solar them applications program [SAND-80-8218] PHOTOVOLTAIC CELLS	p0642 #80-30911 roduction of es, energy ts and se p0702 #80-30951 s demonstration yton systems p0644 #80-31875 mal
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy sources for the plow temperature heat: Energy sources types, and energy conversion; resultipes, and energy conversion; resultipes, and energy sources to promote to [ISBN-3-7041-0038-2] Small solar electric system component thermal storage modules for Bra [NASA-CR-163513] Thermal energy storage for solar thermal polications program [SAND-80-8218]	p0642 #80-30911 rroduction of res, energy ts and se p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 mal
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulapplications; measures to promote upon the property of the property	p0642 #80-30911 rroduction of es, energy ts and se p0702 #80-30951 s demonstration yton systems p0644 #80-31875 mal p0646 #80-31918 dis for solar p0596 A80-45317
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulapplications; measures to promote users [ISBM-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 rroduction of es, energy ts and se p0702 #80-30951 s demonstration yton systems p0644 #80-31875 mal p0646 #80-31918 dis for solar p0596 A80-45317
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resultable applications; measures to promote upon the property of the promote upon the property of the p	p0642 #80-30911 rroduction of es, energy ts and se p0702 #80-30951 s demonstration yton systems p0644 #80-31875 mal p0646 #80-31918 dis for solar p0596 A80-45317
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resultable applications; measures to promote upon the property of the promote upon the property of the p	p0642 #80-30911 rroduction of es, energy ts and ise p0702 #80-30951 s demonstration yton systems p0644 #80-31875 mal p0646 #80-31918 als for solar p0596 #80-45317
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulapplications; measures to promote users [ISBM-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 rroduction of es, energy ts and se p0702 #80-30951 s demonstration yton systems p0644 #80-31875 mal p0646 #80-31918 dis for solar p0596 A80-45504 p0596 A80-45662
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBE-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 rroduction of es, energy ts and ise p0702 #80-30951 s demonstration yton systems p0644 #80-31875 mal p0646 #80-31918 als for solar p0596 #80-45317
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ——— thermal storage modules for Bra [NASA-CR-163513] Thermal energy storage for solar them applications program [SAND-80-8218] PHOTOVOLTAIC CELLS Economic requirements for new material photovoltaic cells Photoelectrochemical conversion using reaction—centre electrodes  Production of photovoltaic devices [ASME PAPER 79-SOL-8] A solar thermophotovoltaic converter Early assessment of the photovoltaic	p0642 #80-30911 rroduction of res, energy ts and se p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 mal p0646 #80-31918 als for solar p0596 #80-45317 p0596 #80-45504 p0596 #80-45662 p0597 #80-46256
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component — thermal storage modules for Brack [NASA-CR-163513] Thermal energy storage for solar them applications program [SAND-80-8218] PHOTOWOLTAIC CELLS Economic requirements for new material photowoltaic cells  Photoelectrochemical conversion using reaction—centre electrodes  Production of photowoltaic devices [ASME PAPEE 79-SOL-8] A solar thermophotowoltaic converter  Early assessment of the photowoltaic potentialities of RAD polysilicon services.	p0642 #80-30911 production of less, energy ts and sep p0702 #80-30951 s demonstration lyton systems p0644 #80-31875 mal p0646 #80-31918 lls for solar p0596 #80-45317 p0596 #80-45504 p0596 #80-45662 p0597 #80-46256 sheets p0600 #80-46701
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component thermal storage modules for Bragnash-CR-163513] Thermal energy storage for solar them applications program [SAND-80-8218] PHOTOVOLTAIC CELLS Economic requirements for new material photovoltaic cells Photoelectrochemical conversion using reaction-centre electrodes  Production of photovoltaic devices [ASMR PAPER 79-SOL-8] A solar thermophotovoltaic converter  Early assessment of the photovoltaic potentialities of RAD polysilicon appropries in the field of terrestrial	p0642 #80-30911 production of less, energy ts and sep p0702 #80-30951 s demonstration lyton systems p0644 #80-31875 mal p0646 #80-31918 lls for solar p0596 #80-45317 p0596 #80-45504 p0596 #80-45662 p0597 #80-46256 sheets p0600 #80-46701
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component — thermal storage modules for Brack [NASA-CR-163513] Thermal energy storage for solar them applications program [SAND-80-8218] PHOTOWOLTAIC CELLS Economic requirements for new material photowoltaic cells  Photoelectrochemical conversion using reaction—centre electrodes  Production of photowoltaic devices [ASME PAPEE 79-SOL-8] A solar thermophotowoltaic converter  Early assessment of the photowoltaic potentialities of RAD polysilicon services.	p0642 #80-30911 rroduction of res, energy ts and se p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 real  p0646 #80-31918 rules for solar p0596 #80-45317 p0596 #80-45504 p0596 #80-45662 p0597 #80-46256 sheets p0600 #80-46701 solar
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ——— thermal storage modules for Bra [NASA-CR-163513] Thermal energy storage for solar them applications program [SAND-80-8218] PHOTOVOLIMIC CRILS Economic requirements for new material photovoltaic cells Photoelectrochemical conversion using reaction—centre electrodes  Production of photovoltaic devices [ASMR PAPER 79-SOL-8] A solar thermophotovoltaic converter Early assessment of the photovoltaic potentialities of RAD polysilicon services in the field of terrestrial generators  The design of photovoltaic systems for	p0642 #80-30911 rroduction of res, energy ts and sep p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 mal p0646 #80-31918 rls for solar p0596 #80-45317 p0596 #80-45504 p0596 #80-45662 p0597 #80-46256 rheets p0600 #80-46701 solar p0602 #80-46713
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component — thermal storage modules for Brack [NASA-CR-163513] Thermal energy storage for solar them applications program [SAND-80-8218] PHOTOWOLTAIC CELLS Economic requirements for new material photowoltaic cells  Photoelectrochemical conversion using reaction—centre electrodes  Production of photowoltaic devices [ASME PAPEE 79-SOL-8] A solar thermophotowoltaic converter  Early assessment of the photowoltaic potentialities of RAD polysilicon appropries in the field of terrestrial generators	p0642 #80-30911 rroduction of res, emergy ts and se p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 real  p0646 #80-31918 rules for solar p0596 #80-45317  p0596 #80-45662 p0597 #80-46256 sheets p0600 #80-46701 solar p0602 #80-46713 r residential
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resultable applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component — thermal storage modules for Brack [NASA-CR-163513] Thermal energy storage for solar them applications program [SAND-80-8218] PHOTOWOLTAIC CELLS Economic requirements for new material photowoltaic cells  Photoelectrochemical conversion using reaction—centre electrodes  Production of photowoltaic devices [ASME PAPEE 79-SOL-8] A solar thermophotowoltaic converter  Early assessment of the photowoltaic potentialities of RAD polysilicon applications in the United States  The design of photowoltaic systems for applications in the United States	p0642 #80-30911 rroduction of res, energy ts and see p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 mal p0646 #80-31918 rls for solar p0596 #80-45317 p0596 #80-45504 p0596 #80-45662 p0597 #80-46256 sheets p0600 #80-46701 solar p0602 #80-46713 r residential p0602 #80-46716
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ——— thermal storage modules for Bra [NASA-CR-163513] Thermal energy storage for solar them applications program [SAND-80-8218] PHOTOVOLIMIC CRILS Economic requirements for new material photovoltaic cells Photoelectrochemical conversion using reaction—centre electrodes  Production of photovoltaic devices [ASMR PAPER 79-SOL-8] A solar thermophotovoltaic converter Early assessment of the photovoltaic potentialities of RAD polysilicon services in the field of terrestrial generators  The design of photovoltaic systems for	p0642 #80-30911 rroduction of res, emergy ts and se p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 real  p0646 #80-31918 ris for solar p0596 #80-45317  p0596 #80-45662 p0597 #80-46256 real real p0602 #80-46713 r residential p0602 #80-46716 rojunctions
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; result applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 rroduction of res, energy ts and see p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 mal p0646 #80-31918 rules p0596 #80-45317 p0596 #80-45504 p0596 #80-45662 p0597 #80-46256 sheets p0600 #80-46701 residential p0602 #80-46713 r residential p0602 #80-46716 rojunctions p0603 #80-46732
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resultanglications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 production of test, energy test and test, energy test and test and test are test and test are t
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; result applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 production of ess, energy ts and see p0702 #80-30951 s demonstration yton systems p0644 #80-31875 mal p0646 #80-31918 tls for solar p0596 #80-45317  p0596 #80-45504 p0596 #80-45662 p0597 #80-46256 sheets p0600 #80-46701 solar p0602 #80-46713 presidential p0602 #80-46716 rojunctions p0603 #80-46732
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 reduction of res, energy r
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 reduction of res, energy r
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 reduction of res, energy ts and sep p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 mal  p0646 #80-31918 rules rul
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; result applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 rroduction of res, energy ts and see p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 real  p0646 #80-31918 rls for solar p0596 #80-45317  p0596 #80-45504 p0596 #80-45662 p0597 #80-46256 residential p0602 #80-46713 r residential p0602 #80-46716 rojunctions p0603 #80-46732 rr cells and p0604 #80-46738 r concentration p0604 #80-46739 rvoltaic
[SAND-80-8203] Regenerative energy sources for the plow temperature heat: Energy source types, and energy conversion; resulting applications; measures to promote to [ISBN-3-7041-0038-2] Small solar electric system component ———————————————————————————————————	p0642 #80-30911 reduction of res, energy ts and see p0702 #80-30951 s demonstration ryton systems p0644 #80-31875 mal  p0646 #80-31918 rules rul

High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination p0606 A80-46768 Advances in theory, fabrication and applications of bifacial solar cells p0606 180-46769 A preliminary 'test case' manufacturing sequence for 50 cents/watt solar photovoltaic modules in p0607 A80-46771 Photovoltaics commercialization readiness assessment p0607 A80-46772 Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773 AlSb as a candidate material for photovoltaic solar energy conversion p0608 A80-46787 Testing flat plate photovoltaic modules for terrestrial environment p0608 A80-46788 Physical/chemical modeling for photovoltaic module life prediction p0608 A80-46790 Cassegrain solar concentrators for photovoltaics p0608 480-46791 20 kW gallium arsenide photovoltaic dense array for central receiver concentrator applications p0608 A80-46793 Engineering studies on the optimization of the collection subsystem of A I MW photovoltaic facility p0609 A80-46794 Influence of meteorological conditions on the design of solar energy dc-ac inverters p0609 A80-46795 Operational characteristics of a 60 kW photovoltaic system integrated with a utility grid p0609 A80-46797
Investigation of high-voltage heterophotoconverters p0611 A80-47163 Photovoltaic systems design and performance for commercial applications p0611 A80-47597 Photocell heat engine solar power systems p0612 A80-48179 Solar thermophotovoltaic space power system p0614 A80-48208 Concentrating photovoltaics - A viable candidate for the next generation of hir Force satellite power systems p0614 A80-48209 Concentrator-enhanced photovoltaic arrays for deep space applications p0614 A80-48210 Photovoltaic central station applications - Status and prospects p0615 A80-48231 Improvement and scale-up of the NASA Redox storage p0767 A80-48370 Current status of growth processes for solar grade silicon p0620 A80-48789 Daily irradiations measured on three photovoltaic systems in Toulouse p0620 A80-48791 Concentrators and solar photovoltaics p0622 A80-50626 Distributed series resistance in photovoltaic devices - Intensity and loading effects p0624 A80-51118 Dimensionless groupings for photovoltaic performance analysis p0624 A80-51463 Silicon solar cell array technology and the prospects for cost reduction p0628 A80-52861 Thin file cuprous sulphide-cadeius sulphide solar cells p0628 A80-52862 Low-cost photovoltaic cell mount study [SAND-80-7006] p0633 N80-28908 Sun Valley photovoltaic power project, phase 1
[ALO-4281-1] p0633 #80

Electrochemical photovoltaic cells, project 65021

[DSE-4042-T8]

p0633 #80-28909

p0742 B80-28910

Study of power management technology for orbital multi-100KWe applications. Volume 3: Photovoltaic generators in space --- conference proceedings, Heidelberg, 15-17 Apr. 1980 [ESA-SP-147] p0658 H80p0658 N80-33873 Requirements p0759 N80-29845 [ BASA-CR- 159834 ] Potential use of terrestrial photovoltaics for Urban solar photovoltaics potential: An inventor and modelling study applied to the San Fernando Valley region of Los Angeles
[NASA-CE-163436] p0636 N80-29 An inventory future space solar arrays p0658 #80-33882 Aspects of large area and thin silicon solar cell Reactively sputtered thin film cu/sub x/S/CdS photovoltaic devices technologies p0658 N80-33884 PHOTOVOLTAIC CONVERSIOR p0637 N80-29875 [UCID-18592] A solar thermophotovoltaic converter p0597 A80-46256 Design of a photovoltaic system for a southwest all-electric residence Selenium heterostructure solar cells [ SAND-79-7056 ] p0598 A80-46259 p0637 H80-29876 Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings Standard procedures for terrestrial photovoltaic performance measurements: Specification no. 101
[BUR-6423EN] p0637 #80-29877

Thin film polycrystalline silicon solar cells
[SAN-2207-T4] p0638 #80-29879 Technology and economics of starting materials for low-cost silicon solar cells p0600 A80-46698 Experimental optimization of the efficiency of Photovoltaic/thermal hybrid projects [BNL-27669] p0638 M Pacific Hissile Test Center energy projects. p0638 N80-29881 n/+/-p-p/+/ and p/+/-n-n/+/ silicon solar cells p0601 A80-46706 Summary of projects, contributions, and plans [AD-A086196] p0581 N80p0581 N80-30903 A revised economic analysis of photovoltaic power Hybrid photovoltaic/thermal systems with a solar-assisted heat pump p0602 A80-46715 p0642 #80-30919 Thin film /CdZn/S for solar cells [BNL-27667] Photovoltaic systems and applications perspective p0603 A80-46727 An S.E.M. study of thin films made by spray pyrolysis --- CdS deposition on solar photovoltaic panels [SAND-80-0926C] p0582 N80-30923 Advanced photovoltaic concentrator cells [DSE-4042-T30] p064
Advanced photovoltaic concentrator cells [DSE-4042-T40] p064 P0643 N80-30946 D0603 A80-46729 p0645 N80-31904 Photovoltaic power generators in space p0604 A80-46735 Analytical prediction of liquid Operation of multi-bandgap concentrator cells with a spectrum splitting filter --- photovoltaic conversion efficiency photovoltaic/thermal flat-plate collector performance [COO-4094-66] p0646 H80-31913 [COU-4094-05] poods 880-319
Residential photovoltaic systems: A review and
comparative evaluation of four independent
studies of potential concepts
[SAND-80-7010] p0648 880-319
Photoelectrochemical solar cells based on d-band
electrochemistry at transition metal diselenides p0604 A80-46740 Integration of photovoltaic generation into a large generating system p0648 N80-31949 Analysis, design and realization of a 5 kW photovoltaic generator [IS-4724] p0648 NBU-Improving the efficiency of silicon solar cells p0605 A80-46745 Study of a hydro-photovoltaic plant for peak power p0648 N80-31952 Containing Chromium
[NASA-CASE-NPO-15179-1]
Operation and maintenance cost data for generation in central and northern European p0650 N80-32850 countries p0605 A80-46746 residential photovoltaic modules/panels
[NASA-CR-163585] p065 AlSb as a potential photovoltaic material p0608 A80-46786 p0650 N80-32855 Description of photovoltaic village power systems in the United States and Africa Residential photovoltaic flywheel storage system performance and cost [ DOB/RT-20279/92] p0587 N80-32874 D0609 A80-46796 Analysis of a passive heat pipe cooled solar photovoltaic receiver [SAND-80-7011] p0651 N GaAs solar cells for space applications p0613 A80-48203 p0651 N80-32885 The applicability of DOB solar cell and array Design and fabrication of combined technology to space power p0613 A80-48206 photovoltaic-thermal collectors [SAND-79-7008] The 100-kWp photovoltaic power system at Watural Bridges Wational Monument p0652 N80-32890 Photovoltaic applications definition and photovoltaic system definition study in the p0615 A80-48227 agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-3289
Analytical prediction of the performance of an air Residential photovoltaic systems p0652 N80-32891 p0615 A80-48228 Residential photovoltaic systems costs photovoltaic/thermal flat plate collector [DOE/ET-20279/93] p0653 p0615 A80-48229 [DOB/RT-20279/93] p0653 880-32914 Electrochemical photovoltaic cells cdSe thin film Intermediate load-center photovoltaic application experiments p0615 A80-48230 electrodes [DSB-4042-T16] 470-kW photovoltaic power system for Saudi Arabia p0654 N80-32925 Research on Cu sub x S/(cd, %n) S photovoltaic solar energy converters villages USDE-10791] p0654 N80-32927 US National Photovoltaics Program and applications experiments in the intermediate sector [SAND-80-0587C] p0654 N80-32037 Simple experip0616 A80-48232 High performance photovoltaic systems p0616 A80-48233 Sandia battery program for energy storage in photovoltaic systems Simple economic evaluation and applications p0767 A80-48368 experiments for photovoltaic systems for remote Residential photovoltaic flywheel storage system performance and cost sites [SAND-80-0749C] p0655 N80-32937 D0768 A80-48377 Gallium arsenide photovoltaic dense array for Thin film solar cells concentrator applications
[SAND-79-2270C] p06
Photovoltaic technology development for p0619 A80-48513 p0655 #80-32938 Photovoltaic conversion - Recent progress in solid state solar cells synchronous orbit p0620 A80-48790 p0657 N80-33470 Open-circuit voltage of induced-junction solar cells p0622 A80-50758 Rockwell Satellite Power System /SPS/ concept Blectrochemical Orbital Energy Storage (ECOES) technology program --- regenerative fuel cell definition studies system

D0780 N80-33473

7 p0623 A80-50953

PHOTOVOLYAIC EFFECT SUBJECT INDEX

	·	
	Photovoltaic solar energy conversion; Proceedings of the Conference, London, England, September 28, 1979	Pittsburgh Energy Technology Center hydrogasification process: Conceptual connercial scale plant design
	p0628 A80-52860 Hybrid thermal-photovoltaic systems	[DOE/EC-08484/T1] p0703 M80-31633 Pipeline gas from coal: Hydrogenation (IGT *
	p0628 A80-52865 Photovoltaics in the U.S.A A progress report	hydrogasification process) [PB-2434-58] p0704 880-31636
	p0629 A80-52866 Emerging materials systems for solar cell	Coal gasification pilot plant support studies [PB-2806-5] p0704 W80-31637
	applications: Cu/sub 2-x/Se [DOE/ET-23005/T3] p0632 N80-28695	Economic evaluation of the MIT process for manufacture of ethanol
	Thin films of InP for photovoltaic energy conversion [COO-3004-2] p0642 B80-30912	[DSE-3992-T1] p0705 N80-31647 Coal demonstration plants
	System design, tests results, and economic analysis of a flywheel energy storage and conversion system for photovoltaic applications	[COE/FE-0004/79-2] p0709 M80-32555 Assessment of Synthane mechanical equipment [MTI-79TE5] p0710 M80-32572
	[COO-4094-70] p0746 N80-30928 Photovoltaic module electrical termination design	Coal liquefaction [DOE/FE-0003/79-2] p0711 N80-32574
	requirement study [JPL-955367-80/1] p0644 N80-31877	Open-cycle MHD systems analysis [EPRI-AP-1316] p0753 M80-32881
	Terrestrial photovoltaic power systems with sunlight concentration	PIONEER VEHUS 2 SPACECRAFT Design and flight performance of the Pioneer Venus
	[SAND-80-7008] p0648 N80-31942 Photovoltaic institutional issues study	Multiprobe and Orbiter solar arrays p0614 A80-48212
	[SAND-79-7054] p0584 880-31950 Analytical evaluation of a solar	PIPE PLOW  Gas distribution equipment in hydrogen service -
	thermophotovoltaic converter [SAND-78-1962] p0649 N80-31954	Phase II p0758 A80-48506
	Photovoltaic applications definition and	PIPELINES
	photovoltaic system definition study in the agricultural sector. Volume 2: Technical results	The HYGAS process to produce pipeline gas from coal p0674 A80-48291
	[SAND-79-7018/2-VOL-2] p0586 N80-32870 Large solar arrays	Experimental design for Hydraulic Transport Research Facility
H	P0657 N80-33471 DTOVOLTAIC EFFECT	[FE-3274-1] p0759 N80-29629 PIPES (TUBES)
	Model for the photovoltaic effect in Cu2S-CdS solar cells in the backwall configuration p0607 A80-46775	Kelp farm and OTBC-1 upwelling pipes p0740 A80-53675 The Cold Water Pipe - Ocean engineering status and
I	LOT PLANTS Status of coal hydrogenation outside Europe	developments p0740 A80-53684
	p0669 A80-45513 Preliminary results from the shrouded wind-turbine pilot plant	Heat pipes. Citations from the NTIS data base [PB80-809940] p0781 N80-28680 OTEC cold water pipe design for problems caused by
	p0722 A80-47525 U.S./U.S.S.R. joint MHD generator testing at the	vortex-excited oscillations [AD-A084555] p0741 B80-28867
	U-25 MHD pilot plant p0724 A80-48223	High temperature thermal energy storage in steel and sand
	Historical development of the U-GAS process at the IGT pilot plant	[NASA-CR-159708] p0776 N80-29860 Besidential solar heating and cooling using
	p0673 A80-48246 Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource	evacuated tube solar collectors: CSU Solar House 3, executive summary (COO-2858-24) p0647 M80-31941
	p0725 A80-48267 Raft River 5-MW/e/ geothermal pilot plant	PISTON ENGINES Analysis and design of free-piston Stirling
	p0727 A80-48314 Development of a compressed air energy storage	engines - Thermodynamics and dynamics p0729 180-48407
	power generation plant - The PEPCO demonstration plant study	Applications of free-piston Stirling engines p0732 A80-48456
	p0767 A80-48338 Design of 40-MW grazing and moored OTEC	An advanced 15 kW solar powered free-piston Stirling engine
	pilot/demonstration plants p0727 A80-48348 Material evaluation and testing program for OTEC	p0619 A80-48467 A state space analysis of a symmetrical compounded free piston Stirling engine
	riser cable  p0728 A80-48351	p0734 A80-48498 Investigation of a Philips MP 1002 CA Stirling
	Wood waste gasification as a source of energy p8679 A80-49540 Development of a methane fermentation process for	engine p0734 A80-48499 An analytical solution for a Stirling machine with
	organic wastes p0679 180-49545	an adiabatic cylinder p0734 A80-48501
	Combustible briquets from waste using the PINEDA/LOAS process	Piston type magnetchydrodynamic motor p0739 A80-52556
	p0683 A80-50009 Materials-related design issues in the solar central receiver pilot plant	PITCE (INCLIBATION) Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and
	p0623 A80-50800 Solaroil project. Phase 1: Preliminary design	variable-controlled blade pitch angle [ISD-258] p0747 N80-30950
	report [GA-A-15823] p0633 N80-29505	PLANAR STRUCTURES  The planar multijunction cell - A new solar cell
	Catalyst development for coal liquefaction [EPRI-AF-1233] p0696 N80-29508	for earth and space p0613 A80-48205
	Multiphase reactor modeling for zinc chloride catalyzed coal liquefaction	PLASMA COMPOSITION Parametric decay into ion cyclotron waves and
	[LBL-9870] p0703 N80-31628  Molten salt coal gasification process development	drift waves in multi-ion species plasma p0735 A80-49071
	unit [SAH-1429-56] p0703 H80-31631	PLASMA COMPRESSION Magnetoplasma compressor with an explosion-driven
		magnetic power generator p0717 A80-44185

SUBJECT INDEX PLASMA WAVES

PLASMA CONTROL Linear analysis of the double-tearing mode in	PLASMA HEATING CT-6 tokamak research - Development and test
tokamak discharges	operation of the experimental device
Neutral-beam energy and power requirements for expanding-radius and full-bore start-up of	p0718 A60-44343 On fusion alpha-particle heating of plasma below ignition
tokamak reactors	p0718 A80-44429
p0719 A80-44656 Particle confinement scaling experiments in the Culham Levitron	Particle confinement scaling experiments in the Culham Levitron p0719 A80-44657
p0719 A80-44657 Combined n equal to 0 and n not equal to 0 MHD	Transport code simulations of lower hybrid heating in tokamaks
stability analysis of axisymmetric surface current model equilibria p0719 A80-44659	p0719 A80-44664 Nonlinear coupling of the slow wave structure with the lower-hybrid waves near the plasma surface
The Tandem Hirror Fusion Test Facility p0720 A80-45850	in controlled fusion p0720 A80-45291
Porm factor for certain types of toroidal solenoids in tokamak fusion devices p0721 A80-47230	Effects of microwave beams on the ionosphere p0757 A80-46881
The Spheromak fusion reactor	A model for laser driven ablative implosions p0735 A80-49069
p0733 A80-48495 An engineering development plan for inertial confinement fusion	Parametric excitation of ion quasi-mode by the pump near the ion cyclotron frequency plasma heating in tokamaks
p0733 A80-48496	p0736 A80-49072
Alteration of Pfirsch-Schlueter transport in tokamaks by all four external sources p0735 A80-49058	Magnetic-pressure acceleration of cylindrical liners by the pulse generators for relativistic electron beams
Bifurcation of sharp boundary beta=1 multipole equilibria plasma confinement in tokamaks	p0736 A80-49098 Some perspectives on the use of powerful gyrotrons
PLASMA CURRENTS	for the electron-cyclotron plasma heating in
CT-6 tokamak research - Development and test	large tokamaks p0738 A80-51038
operation of the experimental device	Economics of shale oil production by radio
p0718 A80-44343 Combined n equal to 0 and n not equal to 0 MHD	frequency heating [UCRL-52942] p0710 N80-32566
stability analysis of axisymmetric surface	PLASMA INTERACTIONS
current model equilibria p0719 180-44659	The feasibility of pellet re-fuelling of a fusion reactor
Bnd effects in a MHD channel with diverging electrode walls	p0719 A80-44661
p0738 A80-50948	Contribution to the theory of the free-field
PLASMA DIAGNOSTICS The Tandem Birror Fusion Test Facility	induction-type MHD engine p0736 A80-49414
p0720 A80-45850 CT-6 tokamak research. II - Experimental results p0721 A80-46670	PLASHA RADIATION  Observations of fluctuating omega sub p emission in Alcator tokamaks
Instability analysis in a nonequilibrium MHD	p0736 A80-49075
generator Thesis p0737 180-50357	PLASMA RESONANCE Destabilization of drift-universal eigenmodes by
PLASMA DIFFUSION	toroidal effects
Particle confinement scaling experiments in the Culham Levitron	PLASHA SHRATHS
p0719 A80-44657 Characterization of open-cycle, coal-fired MHD	Cathode sheaths in potassium seeded MHD combustion plasmas
generators [ARI-RP-46] p0751 N80-32234	p0720 A80-46158 A computer model of solar panel-plasma interactions
PLASHA BLECTRODES	[ MASA-CR-160796 ] p0650 N80-32853
Heat flux at the thermionic collector p0732 A80-48477	PLASMA SLABS Nonlinear coupling of the slow wave structure with
End effects in a MHD channel with diverging electrode walls	the lower-hybrid waves near the plasma surface in controlled fusion
p0738 A80-50948 End zone of a frame-type channel with an	p0720 A80-45291 PLASHA SPECTRA
inhomogeneous flow current and potential fields in plasma	Use of generalized population ratios to obtain Fe XV line intensities and linewidths at high
PLASMA BQUILIBRIUM	electron densities p0735 A80-48763
Energy principle with global invariants for toroidal plasmas	Density profiles in tokamaks from electron cyclotron radiation spectra
p0717 A80-43973 Combined n equal to 0 and n not equal to 0 MHD	p0738 A80-51018
stability analysis of axisymmetric surface current model equilibria	Plasma-sprayed coatings for very high temperature solar absorbers
p0719 A80-44659 Eigenvalue bounds for Bill's equation in	[CONF-791021-3] p0631 #80-28875 PLASMA TEMPERATURE
stability theory for magnetohydrodynamic equilibria	Transport code simulations of lower hybrid heating in tokamaks
p0720 A80-45851 Bifurcation of sharp boundary beta=1 multipole	p0719 A80-44664
equilibria plasma confinement in tokamaks	PLASHA WAVES Nonlinear coupling of the slow wave structure with
p0736 A80-49074	the lower-hybrid waves near the plasma surface
Grad B focusing and deposition of relativistic	p0720 A80-45291
electron beams p0717 A80-43972	Parametric decay into ion cyclotron waves and drift waves in multi-ion species plasma
PO 11 ROV-433/2	p0735 A80-49071

## SUBJECT INDEX

PLASHA-BLECTROMAGNETIC INTERACTION	
	Application of the lime/limestone flue gas
Effects of microwave beams on the ionosphere	desulfurization process to smelter gases
p0757 A80-46881	p0576 180-53084
Theoretical multiple beam overlap from channel transport of intense particle beams	Design of land-based, foam OTEC plants for
p0735 A80-49067	bottoming cycles [CONF-790631-17] p0742 N80-28913
PLASEA-PARTICLE INTERACTIONS	Advanced combustion systems for stationary gas
on fusion alpha-particle heating of plasma below	turbine engines. Volume 2: Bench scale
ignition .	evaluation
p0718 A80-44429	[PB80-175607] p0744 N80-29922
Alteration of Pfirsch-Schlueter transport in	Energy/Environment 4: Proceedings of the National
tokamaks by all four external sources	Conference on the Interagency Energy/Environment
p0735 A80-49058	R and D Program [PB80-177942] p0581 N80-29928
Theoretical multiple beam overlap from channel transport of intense particle beams	[PB80-177942] p0581 H80-29928 Pilot scale combustion evaluation of waste and
p0735 A80-49067	alternate fuels, phase 3
Relativistic-electron-beam/target interaction in	[PB80-177413] p0702 N80-30952
plasma channels	Photochemical study of NCx removal from stack gases
p0735 A80-49068	[PB80-181274] p0582 N80-30966
A computer model of solar panel-plasma interactions	Potential of diesel engine, 1979 summary source
[NASA-CR-160796] p0650 N80-32853	document
PLASMAS (PHYSICS)	[PB80-193659] p0585 N80-32734
Characterization of open-cycle, coal-fired MHD generators	Potential of diesel engine, emission technology [PB80-192685] p0586 N80-32735
[ARI-RP-43] p0750 N80-31936	[PB80-192685] p0586 N80-32735 Environmental implications of electric utility
PLASTIC TAPES	supply plans, 1978-2000
Bending behavior of lapped plastic RHV cables	[PB80-192156] p0588 N80-32963
[BNL-27331] p0760 N80-32789	Environmental control technology for carbon dioxide
PLATES (STRUCTURAL MEMBERS)	[DOE/EV-0079] p0588 N80-32972
Dynamics and control of a continuum model for a	Methanol/ethanol/gasoline blend fuels
solar power system	demonstration with stratified charge engine
[AIAA 80-1740] p0757 A80-45534	Vehicles -0743 mon 22666
PLUMBS Sulfate aerosol production and growth in	[PB80-192123] p0713 H80-33606 International Conference on Air Pollution, volume 1
coal-operated power plant plumes	[ISBN-0-7988-16651] p0592 N80-33929
p0572 A80-48533	Energy conservation-air pollution abatement project
Conversion of mitrogen oxide gases to mitrate	p0592 N80-33939
particles in oil refinery plumes	Energy: Careful conservation or regulated waste
p0572 A80-48534	control of automobile exhaust emissions
Pormation of sulfate particles in the plume of the	p0592 N80-33951
Four Corners Power Plant	International Conference on Air pollution, volume 4
PLUTORIUM p0576 A80-51660	p0592 N80-33954
Assumptions and ground rules used in nuclear waste	Environment: The energy connection p0592 N80-33955
projections and source term data	Environmental air quality control from the inside
[ONWI-24] p0585 N80-32203	looking out
PHEUMATIC CIRCUITS	p0592 N80-33960
Benefits arising from the use of pneumatic energy	Air Pollution control device configurations
transmittal in wind-power systems	[PB80-193253] p0593 N80-33972
PREUMATIC EQUIPMENT	POLLUTION MONITORING
	Sulfate aerosol production and growth in
Comparative study of the energy characteristics of	coal-operated power plant plumes
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation	coal-operated power plant plumes p0572 A80-48533
Comparative study of the energy characteristics of	coal-operated power plant plumes p0572 A60-46533 Conversion of nitrogen oxide gases to nitrate
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports	coal-operated power plant plumes p0572 A80-48533
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAM-1731-T2] p0577 N80-28856 POLLUTION CONTROL Environmental protection - Cooperation versus	coal-operated power plant plumes p0572 180-48533 Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes p0572 180-48534 Pollution control improvements in coal-fired
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLIUTION CONTROL Environmental protection - Cooperation versus enactments	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments p0569 A80-43843	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments p0569 A80-43843 Environmental control technology for atmospheric	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 180-49648
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments p0569 A80-43843 Environmental control technology for atmospheric	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  p0707 180-31986
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLIUTION CONTROL  Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide p0569 A80-45300  Development of steam generator components for open-cycle MHD p0723 A80-48186 pollution control improvements in coal-fired	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/INA-80-9 (M)]  p0589 N80-32983
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAH-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/IEA-80-9(M)]  International Conference on Air pollution, volume 4
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/IEA-80-9(M)]  International Conference on Air pollution, volume 4 p0592 N80-33954
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/IEA-80-9[M]] p0589 N80-32983 International Conference on Air pollution, volume 4 p0592 N80-33954
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  [POS69 A80-43843]  Environmental control technology for atmospheric carbon dioxide  [POS69 A80-45300]  Development of steam generator components for open-cycle MHD  [PO723 A80-48186]  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  [PO573 A80-49648]  Environmental impact of conversion of refuse to	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769] p0707 180-31986  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEM-80-9(M)] p0589 180-32983 International Conference on Air pollution, volume 4 p0592 180-33954  POLYCHISTALS HIS and SIS solar cells on polycrystalline silicon
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Environmental impact of conversion of refuse to energy	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769] p0707 N80-31986  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEA-80-9(M)] p0589 N80-32983 International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCRYSTALS  MIS and SIS solar cells on polycrystalline silicon p0597 A80-46257
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  [POS69 A80-43843]  Environmental control technology for atmospheric carbon dioxide  [POS69 A80-45300]  Development of steam generator components for open-cycle MHD  [PO723 A80-48186]  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  [PO573 A80-49648]  Environmental impact of conversion of refuse to	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEA-80-9[M]]  International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCRYSTALS MIS and SIS solar cells on polycrystalline silicon p0597 A80-46257 Theory of polycrystalline silicon solar cells
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  Environmental control technology for atmospheric carbon dioxide  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  Environmental impact of conversion of refuse to energy	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/IEA-80-9 (M)] International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCHYSTALS MIS and SIS solar cells on polycrystalline silicon p0597 A80-46257 Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MBD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  Environmental impact of conversion of refuse to energy  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEA-80-9[M]]  International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCHYSTALS MIS and SIS solar cells on polycrystalline silicon p0597 A80-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769] p0707 180-31986  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEM-80-9(H)] p0589 180-32983 International Conference on Air pollution, volume 4 p0592 180-33954  POLYCHYSTALS  MIS and SIS solar cells on polycrystalline silicon p0597 180-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  p0597 180-46258  Early assessment of the photovoltaic
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants p0574 A80-49961  Effluent-free flue gas scrubbing process to	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/IEA-80-9(M)]  International Conference on Air pollution, volume 4 p0592 N80-32983  International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCEYSTALS  MIS and SIS solar cells on polycrystalline silicon p0597 A80-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  p0597 A80-46258  Early assessment of the photovoltaic potentialities of RAD polysilicon sheets
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MBD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  Environmental impact of conversion of refuse to energy  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toric gases and steam generation in refuse incineration plants p0574 A80-49961  Effluent-free flue gas scrubbing process to separate the fine dust and the noxions gases	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEA-80-9[M]]  International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCHYSTALS  MIS and SIS solar cells on polycrystalline silicon p0597 A80-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  p0597 A80-46258  Barly assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 A80-46701
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  [POSCONTROL POSCONTROL POSCONTRO	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769] p0707 N80-31986  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEM-80-9(H)] p0589 N80-32983 International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCHYSTALS  MIS and SIS solar cells on polycrystalline silicon p0597 A80-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  p0597 A80-46258  Early assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 A80-46701 A computer model for polycrystalline Si n/plus//p
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAM-1731-T2] p0577 M80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  Environmental impact of conversion of refuse to energy  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants  p0574 A80-49961  Effluent-free flue gas scrubbing process to separate the fine dust and the noxious gases from waste combustion plants	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/IEA-80-9(M)]  International Conference on Air pollution, volume 4 p0592 180-33954  POLYCHYSTALS  MIS and SIS solar cells on polycrystalline silicon p0597 180-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  p0597 180-46258  Early assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 180-46701  A computer model for polycrystalline Si n/plus//p solar cells
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  [POSCONTROL POSCONTROL POSCONTRO	coal-operated power plant plumes  p0572 A80-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769] p0707 N80-31986  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEM-80-9(H)] p0589 N80-32983 International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCHYSTALS  MIS and SIS solar cells on polycrystalline silicon p0597 A80-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  p0597 A80-46258  Early assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 A80-46701 A computer model for polycrystalline Si n/plus//p
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAH-1731-T2] p0577 M80-28856  POLLUTION CONTROL Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  Environmental impact of conversion of refuse to energy  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants p0574 A80-49961  Effluent-free flue gas scrubbing process to separate the fine dust and the noxious gases from waste combustion plants  p0574 A80-49968  Energy expenditure for environmental protection - A contribution to efficiency analysis p0575 A80-50819	Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  P0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  P0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, What they cost  P0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results  [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use  [OBAU/IEA-80-9(M)]  International Conference on Air pollution, volume 4 p0592 N80-32983  International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCHISTALS  MIS and SIS solar cells on polycrystalline silicon p0597 180-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  P0597 180-46258  Early assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 180-46701  A computer model for polycrystalline Si n/plus//p solar cells  P0606 180-46766  Current status of growth processes for solar grade silicon
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  Environmental impact of conversion of refuse to energy  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toric gases and steam generation in refuse incineration plants  p0574 A80-49961  Effluent-free flue gas scrubbing process to separate the fine dust and the noxions gases from waste combustion plants  p0574 A80-49968  Energy expenditure for environmental protection - A contribution to efficiency analysis  p0575 A80-50819  Optimization problems of emission reduction in	Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  P0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  P0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, What they cost  P0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results  [P80-182769]  Constraints on carbon dioxide production from fossil fuel use  [ORAU/LEA-80-9[M]]  International Conference on Air pollution, volume 4 p0592 N80-33954  POLYCHYSTALS  MIS and SIS solar cells on polycrystalline silicon p0597 180-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  P0597 180-46258  Barly assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 180-46701  A computer model for polycrystalline Si n/plus//p solar cells  P0606 180-46766  Current status of growth processes for solar grade silicon  P0620 180-48789
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports  [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  [Possible of the control technology for atmospheric carbon dioxide p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide p0569 A80-45300  Development of steam generator components for open-cycle MHD p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost p0573 A80-49648  Environmental impact of conversion of refuse to energy p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants p0574 A80-49961  Effluent-free flue gas scrubbing process to separate the fine dust and the noxions gases from waste combustion plants  p0574 A80-49968  Energy expenditure for environmental protection - A contribution to efficiency analysis  p0575 A80-50819  Optimization problems of emission reduction in large fossil-fuel combustion facilities	coal-operated power plant plumes  p0572 180-48533  Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  p0572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  p0573 180-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769] p0707 180-31986  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEM-80-9(H)] p0589 180-32983  International Conference on Air pollution, volume 4 p0592 180-33954  POLYCHYSTALS  MIS and SIS solar cells on polycrystalline silicon p0597 180-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  p0597 180-46258  Early assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 180-46701  A computer model for polycrystalline Si n/plus//p solar cells  p0606 180-46766  Current status of growth processes for solar grade silicon  p0620 180-48789  Visible light response of polycrystalline TiO2
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  Environmental impact of conversion of refuse to energy  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants p0574 A80-49961  Effluent-free flue gas scrubbing process to separate the fine dust and the noxious gases from waste combustion plants  p0574 A80-49968  Energy expenditure for environmental protection - A contribution to efficiency analysis  p0575 A80-50819  Optimization problems of emission reduction in large fossil-fuel combustion facilities  p0576 A80-51500	Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  po572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  po573 180-48534  Pollutants from synthetic fuels production: Coal gasification screening test results  [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/IEA-80-9(M)]  International Conference on Air pollution, volume 4 p0592 180-33954  POLICEISTALS  HIS and SIS solar cells on polycrystalline silicon p0597 180-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  po597 180-46258  Early assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 180-46701  A computer model for polycrystalline Si n/plus//p solar cells  p0606 180-46766  Current status of growth processes for solar grade silicon  Visible light response of polycrystalline TiO2 electrodes for solar energy conversion
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  Environmental impact of conversion of refuse to energy  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants  p0574 A80-49961  Effluent-free flue gas scrubbing process to separate the fine dust and the noxions gases from waste combustion plants  p0574 A80-49968  Energy expenditure for environmental protection - A contribution to efficiency analysis  p0575 A80-50819  Optimization problems of emission reduction in large fossil-fuel combustion facilities  p0576 A80-51500  Energy choices and environmental constraints	Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  po572 A80-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  po573 A80-49648  Pollutants from synthetic fuels production: Coal gasification screening test results [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/LEA-80-9[M]] po589 N80-32983  International Conference on Air pollution, volume 4 po592 N80-33954  POLYCHYSTALS  MIS and SIS solar cells on polycrystalline silicon po597 A80-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  po597 A80-46258  Barly assessment of the photovoltaic potentialities of RAD polysilicon sheets po600 A80-46701  A computer model for polycrystalline Si n/plus//p solar cells  po606 A80-46766  Current status of growth processes for solar grade silicon  po620 A80-48789  Visible light response of polycrystalline Ti02 electrodes for solar energy conversion po664 A80-51691
Comparative study of the energy characteristics of powered hand tools. Part 2: Investigation reports [SAN-1731-T2] p0577 N80-28856  POLLUTION CONTROL  Environmental protection - Cooperation versus enactments  p0569 A80-43843  Environmental control technology for atmospheric carbon dioxide  p0569 A80-45300  Development of steam generator components for open-cycle MHD  p0723 A80-48186  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  Environmental impact of conversion of refuse to energy  p0573 A80-49648  Environmental impact of conversion of refuse to energy  p0574 A80-49954  The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants p0574 A80-49961  Effluent-free flue gas scrubbing process to separate the fine dust and the noxious gases from waste combustion plants  p0574 A80-49968  Energy expenditure for environmental protection - A contribution to efficiency analysis  p0575 A80-50819  Optimization problems of emission reduction in large fossil-fuel combustion facilities  p0576 A80-51500	Conversion of nitrogen oxide gases to nitrate particles in oil refinery plumes  po572 180-48534  Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost  po573 180-48534  Pollutants from synthetic fuels production: Coal gasification screening test results  [PB80-182769]  Constraints on carbon dioxide production from fossil fuel use [ORAU/IEA-80-9(M)]  International Conference on Air pollution, volume 4 p0592 180-33954  POLICEISTALS  HIS and SIS solar cells on polycrystalline silicon p0597 180-46257  Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary recombination states  po597 180-46258  Early assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 180-46701  A computer model for polycrystalline Si n/plus//p solar cells  p0606 180-46766  Current status of growth processes for solar grade silicon  Visible light response of polycrystalline TiO2 electrodes for solar energy conversion

SUBJECT INDEX POPER SUPPLIES

·	
POLIETHILEBES Gas distribution equipment in hydrogen service -	Energy conversion considerations of the STARFIRE commercial fusion power plant
Fhase II p0758 A80-48506	p0733 A80-48490 Transient behaviour of wind energy systems
POLYIMIDES  Development of polyimide materials for use in  solar energy systems	p0734 A80-48521 Wake decay and power reduction in wind farm arrays - An application to the array proposed for the
[DOB/CS-35305/T2] p0636 H80-29870	Rahuku Hills
POLITIES  Development status of the General Electric solid	p0735 A80-48523 Small windmills in Denmark
polymer electrolyte water electrolysis technology	p0735 A80-48525
POEDS p0662 A80-48413	Puel cell systems for vehicular applications [SAE PAPER 800059] p0736 A80-49720
Organic material emissions from holding ponds at	Efficiency of coal use, electricity for BVs versus
coal-fired power generation facilities [EPRI-EA-1377] p0589 N80-32987	synfuels for ICRs [SAE PAPER 800109] p0680 A80-49727
POROSITY	The combined firing of coal and waste derived fuel
Collector sealants and breathing [DOE/CS-15362/1] p0650 B80-32527	in steam raising plant p0681 A80-49956
POROUS MATERIALS	The combustion engineering approach to municipal
Testing of sintered LiAlO2 structures in molten carbonate fuel cells	solid waste energy recovery
p0721 A80-47143	Kiener pyrolysis, a link between waste disposal
Temperature-induced permeability alterations in unconsolidated and consolidated aquifer media	and energy supply p0682 A80-49983
for seasonal thermal energy storage	Performance of a low cost cross-wind-axis
p0766 A80-48336 Porous media experience applicable to field	sail-wind turbine p0738 A80-51124
evaluation for compressed air energy storage [PNL-3294] p0777 N80-32873	Predicted effect of grid line aspect ratio on the
[PNL-3294] p0777 H80-32873 POTASSION	performance of solar cells p0625 A80-51687
Cathode sheaths in potassium seeded HHD combustion plasmas	The operating region of MHD generators p0739 A80-51721
p0720 A80-46158	Applications of DOE-1 to passive solar heating of
POTASSIUM HITRATES Investigation of nitrate salts for solar latent	commercial buildings - Preliminary results p0626 A80-52831
heat storage	Measurement of natural convection in air-cooled
POURE CONDITIONING POSS A80-45316	solar collectors p0627 A80-52834
Dc to ac power conditioning for photovoltaic	A semi-empirical method for estimating the
arrays and utility interfacing p0605 180-46744	performance of direct gain passive solar beated buildings
Power processing and control requirements of	p0627 A80-52838
dispersed solar thermal electric generation systems	Simple design calculation procedure for passive solar houses
POWER CONVERTERS	p0627 A80-52839 Performance characteristics of a commercially
Preliminary design for the power take-off of	available, point-focus, solar power system
singly-loaded magnetohydrodynamic channels p0738 A80-50947	p0629 A80-53570 Synchronous Energy Technology
POWER SPRICIENCY	[NASA-CP-2154] p0656 N80-33465
Heat exchanger effectiveness for solar collectors p0596 A80-45320	Air Force space power technology program p0782 N80-33468
The behavior of a closed-cycle gas turbine with	POWER LINES
time dependent operating conditions [ASME PAPEE 79-G1/ISE-2] p0720 A80-45663	Material evaluation and testing program for OTEC riser cable
Matching of a radioisotopic thermoelectric	p0728 A80-48351
generator and an energy accumulator p0720 A80-46599	Thermal resource availability ocean
Fickel hydrogen battery for load leveling application	temperature data base for OTEC purposes p0718 A80-44603
p0766 A80-48328	The behavior of a closed-cycle gas turbine with
The OASIS computer program for optimization and simulation of integrated systems for energy	time dependent operating conditions [ASME PAPER 79-GT/ISR-2] p0720 A80-45663
production and utilization at community level	Stirling engine power system development and test
p0571 180-48333 Overview of high efficiency power cycles for fusion	results p0731 180-48453
p0728 A80-48358	Stirling engines for developing countries
Comparison of advanced engines for parabolic dish solar thermal power plants	p0732 A80-48454 Applications of free-piston Stirling engines
p0618 A80-48418 Design study of a coal-fired thermionic	p0732 A80-48456 Services rendered for waste incineration power
/THI/-topped power plant	plants technology and implementation exemplified
p0730 A80-48422 Development of a diaphragm Stirling engine	with the waste incineration heating power plant of the seaport of Bremerhaven
heat-actuated heat pump	p0682 A80-49966
p0731 A80-48425 Design characteristics and test results of the	Formation of sulfate particles in the plume of the Four Corners Power Plant
United Stirling P40 engine	p0576 A80-51660
p0731 A80-48452 Off-peak power for hydrogen production	Development of high-temperature turbine subsystem technology to a technology readiness status,
P0663 A80-48461	phase 2
Thermionic converter output as a function of collector temperature	[FE-1806-86] p0701 N80-30753 POWER SUPPLIES
p0732 A80-48476 Test evaluation of a prototype 18-ton solar	Selection of the optimal design parameters of an aircraft flywheel-type power supply system
powered heating and cooling system	p0761 A80-47391
p0619 A80-48480	

POWER TRANSMISSION SUBJECT INDEX

Ensured power supply and environme		Refining and upgrading of synfuels from coal a	and
as elements of a provident socia		oil shales by advanced catalytic processes	
POWER TRANSMISSION	p0575 A80-50825	[FE-2315-40] p0691 H80 Process evaluation: Steam reforming of diesel	
Plywheel-transmission characterist	ics required for	fuel ail:	•
<ul> <li>break-even impact on automotive</li> </ul>		[AD-A087053] p0699 H80	-3053
performance		Upgrading of coal liquids for use as power '	-
PRECIPITATORS	p0768 A80-48378	generation fuels [BPRI-AF-1225] p0699 H80	3-305h
Environmental air quality control	from the inside	[BPRI-AF-1225] p0699 H80 Underground gasification for steeply dipping of	
looking out		beds. Bawlins test no. 1	
	p0592 B80-33960	[SAN-13108-35] . p0705 N80	
PREDICTION ANALYSIS TECHNIQUES	14	Instrumentation and process control developmen	ıt
Solar energy applications for dwel and simulation part	ling; modelling	for in situ coal gasification [SAND-80-1025] p0706 N80	-3165
[EUR-6681/I-EN]	p0645 N80-31894	Mixing and gasification of coal in entrained f	
Potential of spark ignition engine	, effect of	systems. Volume 2: User's manual for a	
vehicle design variables on top	speed,	computer program for 1-dimensional coal	
performance, and fuel economy [PB80-191836]	p0586 N80-32736	combustion or gasification (1-DICOG) [FE-2666-F-VOL-2] p0706 B80	-3165
Evaluation of hydropower potential		Development of combustion data to utilize low-	
Prediction analysis techniqu		gases as industrial process fuels: Modifica	
	p0755 #80-33856	of flame characteristics	
The SWAB (Spectral Wave And Bar) p		[DOE/ET-14851/2] p0706 N80	
[PB80-196041] PREDICTIOES	p0714 N80-34052	Synthetic fuels from US oil shales: A technic and economic verification of the HY1ORT proc	
Investigation of learning and expe	rience curves	[DOE/ET-14102/3] p0710 H80	
[SERI/TR-353-459]		PRODUCT DEVELOPMENT	
PRESERVING	_	Development of a lithium-water-air primary bat	tery
Carbohydrate crops as a renewable		for automotive propulsion p0768 A80	
fuels production. Volume 3: Ju [BMI-2031-VOL-3]	p0696 B80-29511	Induced junction solar cell and method of	-4637
PRESIDENTIAL REPORTS	P0000 200 250	fabrication	
The global 2000 report to the pres		[ NASA-CASE-NPO-13786-1 ] p0634 N80	
the twenty-first century. Volum		Design of a cost effective solar powered water	
technical report trends in p climate, gross national product,		[PB80-182819] p0649 N80 Coal liquefaction	1-3190
resources, technology, and man e		[DOE/PE-0003/79-2] p0711 H80	-3257
interactions	, ,	Advanced technology fuel cell program	
_ <u></u>	p0782 N80-32296	[EPRI-RM-1328] p0752 N80	-3287
PRESSURE DISTRIBUTION	1 4- 41-	Design and fabrication of combined	
Pseudo-shock as a qualitative mode investigation of the influence o		photovoltaic-thermal collectors [SAND-79-7008] p0652 N80	-3289
on the performance of supersonic		Photovoltaic technology development for	
[AD-A088333]	p0754 #80-33228	synchronous orbit	
PRESSURE DROP		p0657 N80	-3347
Pressure loss in a spiral solar en	p0624 A80-50971	PRODUCTION ENGINEERING  Eydrogen and oxygen from water. III - Evaluati	OB.
PRESSURE EFFECTS	p. 024 200 303.1	of a hybrid process	.01
The influence of contact pressure		p0661 A80	-4529
performance of supported gas dif		Production of photovoltaic devices	
electrodes in alkaline H2-02-fue	p0739 A80-51459	[ASHE PAPER 79-SOL-8] p0596 A80 A high volume process for silicon solar cells	-4566
PRESSURIZING	PO123 EGG-21423	using solid diffusion sources	
Miniplant and bench studies of pre	ssuri 2ed	p0601 A80	-4670
fluidized-bed coal combustion		A preliminary 'test case' manufacturing sequen	
[PB80-188121]	P0712 N80-32999	for 50 cents/watt solar photovoltaic modules	in
PRETERATEUR Pipeline gas from coal: Hydrogena	tion (TCT	1986 · p0607 A80	L-11677
hydrogasification process)	(101	Potential for biological conversion of biomass	
[PB-2434-58]	p0704 880-31636	liquid fuels	
Coal gasification pilot plant supp	ort studies	p0675 A80	
[PE-2806-5] PRIMARY BATTERIES	p0704 N80-31637	Permentation ethanol as a petroleum substitute	
Development of a lithium-water-air	primary battery	p0675 A80 Aerospace nickel-cadmium/nickel-hydrogen elect	
for automotive propulsion		process facility :	
	p0768 A80-48372	p0769 A80	-4839
Hybrid lithium/nickel-zinc large m	issile ground	Alcohol fuels for spaceship earth	
power source	p0772 A80-48489	p0686 A80 Coplanar back contacts for thin silicon solar	
PRINTING	<b>P</b>	[HASA-CR-159811] p0630 H80	
Overview of thick-film technology	as applied to	PROJECT HANAGEMENT	
solar cells		A synergistic solid waste to energy project -	
[SERI/TP-331-541] PROBABILITY DISTRIBUTION PUBCTIONS	p0639 N80-29895	Phase 1 project concept	
Analytic representation of distrib	ution laws for	p0570 A80 Assessment of risks in the financing of major	-4130
energy structure of solar-radiat		energy projects '	
		p0573 A80	-4939
PROCEEDINGS	p0611 A80-47161		
	p0611 A80-47161	Status of the satellite power system concept	
Proceedings of the Ocean Energy In	p0611 A80-47161	development and evaluation program	
Proceedings of the Ocean Energy In Dissemination Workshop	p0611 A80-47161		
Proceedings of the Ocean Energy In Dissemination Workshop [SEEL/TP-732-600] PROCESS CONTROL (INDUSTRY)	p0611 A80-47161 formation p0753 N80-32956	development and evaluation program p0623 A80	
Proceedings of the Ocean Energy In Dissemination Workshop [SERI/TP-732-600] PROCESS COTTOL (INDUSTRY) Cryogenic methane separation/catal	p0611 A80-47161  formation  p0753 N80-32956  ytic	development and evaluation program p0623 A80 PROJECT PLANNING The Department of Energy's major project coal liquefaction program	-5095
Proceedings of the Ocean Energy In Dissemination Workshop [SEBI/TP-732-600] PROCESS CONTROL (INDUSTRY) Cryogenic methane separation/catal hydrogasification process analys	p0611 A80-47161  formation     p0753 N80-32956  ytic is	development and evaluation program p0623 A80 PROJECT PLANNIEG The Department of Energy's major project coal liquefaction program p0677 A80	-5095 -4842
Proceedings of the Ocean Energy In Dissemination Workshop [SERI/TP-732-600] PROCESS COTTOL (INDUSTRY) Cryogenic methane separation/catal	p0611 A80-47161  formation  p0753 N80-32956  ytic	development and evaluation program p0623 A80 PROJECT PLANNING The Department of Energy's major project coal liquefaction program	-5095 -4842

SUBJECT INDEX PADIANT FLUX DRESTTY

Electric utility solar energy activi	ities:	PYRCHIDECLISIS		
1979survey [RPRI-BR-1299-SR]	p0631 880-28879	The flash hydropyrolysis of lignite sub-bituminous coals to both liqui		
NASA program plan	٠,	hydrocarbon products	r	
[ NA SA-TM-81136 ]	p0781 H80-31269		p0679 A80-496	<b>j</b> 26
Satellite power system (SPS) concept		PYROLYSIS	•	
study. Volume 3: Experimental ve	erification	An S.E.M. study of thin films made b		
definition		pyrolysis CdS deposition on so	lar	
	P0651 B80-32860	photovoltaic panels		
ROPULSION SISTEM CONFIGURATIONS	W-1m 2-	Host and made transfer annual dum	p0603 A80-467	/29
Hybrid vehicle potential assessment. Parallel systems	. Actime 2:	Heat and mass transfer processes dur pyrolysis of antrim oil shale	ing the	
	p0776 M80-31270	[ASHE PAPER 80-HT-123]	p0671 A80-480	139
Electric and hybrid vehicle system		Plash pyrolysis and gasification of		,,,,
development project, hybrid vehica		laser heating		
assessment. Volume 4: Series sys		<u>-</u>	p0672 A80-482	244
[CONS-4209-T1-VOL-4]	P0748 #80-31273	The CS/R advanced SNG hydrogasificat	ion process	
Plywheel energy management systems i		· · · · · · · · · · · · · · · · · · ·	p0674 A80-482	292
the fuel economy of motor vehicles		Liquid products from peat pyrolysis		
[PB80-175300]	p0777 N80-31278	Parada	p0677_A80~483	385
ROPULSIVE EFFICIENCY	fiold	Reaction modelling and correlation f	or ilasn	
Contribution to the theory of the fi induction-type MHD engine	ree_trerd	hydropyrolysis of lignite	p0678 A80-484	,,,,
indection type and engine	p0736 A80-49414	Production of light aromatics from c		
ROTON IRRADIATION		i .	p0680 A80-496	
Effects of thermal annealing on the	deep-level	Integrated system for solid waste di	sposal with	
defects and I-V characteristics of		energy recovery and volumetric red	uction by new	
proton irradiated AlGals-Gals sol		pyrolysis furnace		
homomynus :	p0613 A80-48204	Firmer proclasis - link between wer	p0682 A80-499	182
AOTOTIPES Interim status report on DOE protot	translavah	Kiener pyrolysis, a link between was and energy supply	re disposai	
SWECS Small Wind Energy Conver		414 010131 DEFF1	p0682 A80-499	983
	p0726 A80-48270	D.C. electrical conductivity of Gree		
Material evaluation and testing pro-	gram for OTEC	shales		
riser cable	0700 -00 10354	01-1-1	p0685 A80-502	278
UBLIC HRALTH	p0728 A80-48351	Global model of countercurrent coal	gasifiers - p0686 <b>A80-51</b> 5	<b>-74</b>
The direct use of coal. Volume 2,	nart C:	The hydropyrolysis of coal to BTY		
Working papers, appendices 10-14		Toluene and Xylenes		
[PB80-184534]	p0697 N80-29522		p0688 A80-531	
Possil fuels research matrix program		Methane formation during hydrogen ga		i.
Environmental Protection Agency/De		gas phase pyrolysis of selected ar		A 2 M
Energy Fossil Fuels Research Mater [ORNL/TH-7346]	p0583 N80-31632	Gasification of coal with solar ener	p0689 A80-540	134
International Conference on Air Pol		[UCRL-84458]	p0643 N80-316	652
[ISBN-0-7988-16651]	p0592 N80-33929	Coal processing for fuel cell utiliz		
Environmental air quality control fi		9: One-dimensional (streamtube) m		
looking out		entrained-flow gasifier analysis		
	P0592 N80-33960	[ MBTC-8450-T2-VOL-1]	p0707 N80-319	12
Health requirements for advanced coa	al extraction	Plash pyrolysis and gasification of	coal through .	
systems [NASA-CE-163625]	p0714 N80-34093	laser heating [LA-UR-80-1094]	p0711 N80-325	<b>57</b> 3
UBLIC BELATIONS	povit 200 34035	Hydroprocessing of light pyrolysis f		
Some questions and answers about the	e Satellite	kerosene type jet fuel		
Power System (SPS)	,	[AD-A089101]	p0713 N80-335	599
	p0639 N80-29897	•	•	
UBRIO RICO		Q	• .	
Concentrating photovoltaics for the [DOB/CS-04270/1]	p0656 #80-32954	QUARTS	•	
ULLBIS	P0030 H00 32334	Progress on the Dow Corning process	for.	
Design study of steel V-Belt CVT for	r electric	solar-grade silicon		
vehicles			p0600 A80-466	699
[NASA-CR-159845]	p0777 N80-32299	QUEECHIEG (COOLIEG)		•
ULSE GENERATORS	-lind-ionl	Partial liquefaction of coal by dire [FB-2044-51]		
Hagnetic-pressure acceleration of colliners by the pulse generators for		QUEUELEG THEORY	p0699 N80-305	,40
electron beams	10144110110	Optimum systems design with random i	nout and	
,	p0736 A80-49098	output applied to solar water heat		
ULSED LASERS	٠.		p0657 N80-338	354
Momentum transfer of laser radiation		QUINOLINE		
inhomogeneous dielectrics The	p0737 180-50356	Development of unique catalysts for hydrodenitrogenation of coal-deriv	ed lianida	_
UMPS	p0.37 200-30330	decahydroquinoline and quinoline	on triantes	
Design, construction, and operation	of a 150 kW	[ PR-3297-3 ]	p0690 N80-285	546
solar-powered irrigation facility	, phase 2			
[ALO-4159-1]	.p0645 N80-31903	$\mathbf{R}_{i}$		
Solar powered rankine cycle irrigati		RADIAL PLOU	•	
[DOE/ET-20419/1] YRIDIBES	p0652 N80-32892	A water-influx model for UCG with		. 1
Average chemical structure of mild i	hydrogenolysis	spalling-enhanced drying Under	ground Coal	
products of coals	_	Gasification		
YROBLECTRICITY	:p0679 A80-49628	DINTING DINY ADROTMS	p0676 A80-483	143
TRUBLECIBLE IT DEMONSTRATION of heat to electrical	energy	RADIAST PLUX DEBSITY  Irradiance on the receiver of a gene	ral optical	
conversion with a ferroelectric man		concentrator		
	p0729 A80-48386		- p0610 A80-470	143

•	
RADIANT HEATING	Some perspectives on the use of powerful gyrotrons
A study of the heat-induced fracture	for the electron-cyclotron plasma heating in
characteristics of materials under intense	large tokamaks
radiant heating	p0738 A80-51038
p0609 A80-46815	Economics of shale oil production by radio
Energy savings obtainable through passive solar	frequency heating
techniques	[UCBL-52942] p0710 H80-32566
[LA-UR-80-746] p0632 B80-28891	RADIOACTIVE WASTES
Solar passive systems for buildings [NP-24377] p0643 N80-30947	Overview of nuclear fuel cycle
Solar heating system at Quitman County Bank,	[CONF-791185-3] p0698 N80-30171
Harks, Bississippi	Assumptions and ground rules used in nuclear waste projections and source term data
[MASA-CE-161549] p0657 #80-33858	[OBWI-24] p0585 N80-32203
Installation, operation, and maintenance for the	EADIOISOTOPE BATTERIES
pyramidal optics solar system installed at Yacht	Matching of a radioisotopic thermoelectric
Cover, Columbia, South Carolina	generator and an energy accumulator
[ MASA-CH-161203 ] p0657 M80-33864	p0720 A80-46599
RADIATION DANAGE	RTG power source for the International Solar Polar
Degradation effects in silicon Schottky barrier	Mission
solar cells	p0727 A80-48305
p0601 A80-46709	RANDOM LOADS
The stability of amorphous silicon	Combined effects of periodic and stochastic loads
Schottky-barrier solar cells	on the fatigue of wind turbine parts, part 6
p0602 A80-46722	[FPA-AU-1499-PT-6] p0741 H80-28732
Effects of thermal annealing on the deep-level	BANKIBB CYCLB
defects and I-V characteristics of 200 keV	Ocean thermal energy conversion - A general
proton irradiated AlGaAs-GaAs solar cells	introduction
p0613 A80-48204	p0718 A80-44599
Radiation damage in high voltage silicon solar cells	Working fluids for solar, Hankine-cycle cooling
p0658 880-33889	systems
Analytic representation of distribution laws for	p0595 180-45299
energy structure of solar-radiation regime	Solar-powered Rankine engine assists air
p0611 A80-47161	conditioning systems with electrical generating
Maximum solar flux concentration achievable with	capability p0611 A80-47596
axicon collectors	Optimum working fluids for solar powered Rankine
p0625 A80-51679	cycle cooling of buildings
RADIATION REFECTS	p0625 A80-51681
Effects of microwave beams on the ionosphere	Steam engine analysis
p0757 A80-46881	[FE-8917-2] p0743 #80-29741
Radiation effects on solar cells	Overview-absorption/Rankine solar cooling program
p0609 A80-46894	[LBL-10770] p0640 x80-29904
The effect of direct and diffuse radiations on the	Solar Central Receiver Hybrid Power Systems
thermal performance of flat-plate solar collectors	sodium-cooled receiver concept. Volume 2, book
p0620 A80-48793	<ol> <li>Conceptual design, sections 1 through 4</li> </ol>
RADIATION MEASUREMENT	[DOE/ET-20567/1-2-BK-1] p0645 B80-31896
Daily irradiations measured on three photovoltaic	Solar Central Receiver Hybrid Power Systems
systems in Toulouse	sodium-cooled receiver concept. Volume 2, book
p0620 A80-48791	2: Conceptual design, sections 5 and 6
Observations of fluctuating omega sub p emission	[DOE/ET-20567/1-2-BK-2] p0645 B80-31897
in Alcator tokamaks	Solar central receiver hybrid power systems
p0736 A80-49075	sodium-cooled receiver concept. Volume 1:
RADIATION PROTECTION	Brecutive summary
Radiation effects on solar cells	[DOB/BT-20567/1-1] p0648 #80-31948
p0609 A80-46894	Solar powered rankine cycle irrigation pump
Thin, high efficiency silicon solar cells 56	[DOE/ET-20419/1] p0652 N80-32892
micrometers thick	
p0658 N80-33885	A parametric study of 1000 MWe combined closed cycle MHD/system electrical power generating
BADIATIVE HEAT TRANSPER	plants
Convective-radiative interaction in a parallel	[TB-78-E-91] p0742 N80-28931
plate channel - Application to air-operated	RAY TRACING
solar collectors	High concentration solar collector of the stepped
. р0598 А80-46349	spherical type - Optical design characteristics
Comparison of use of Hottel chart and the zone	p0629 A80-53263
method for radiative heat transfer in our open	RC CIRCUITS
cycle MHD radiant boiler	Simulation of a solar energy system by means of an
[ASHE PAPER 80-HT-44] p0722 A80-48022	electrical resistance network
Coal processing for fuel cell utilization: Task	p0625 A80-51686
9: One-dimensional (streamtube) model for	RCA SATCOM SATELLITES
entrained-flow gasifier analysis	RCA Satcom P1 and P2 Ni-Cd battery orbital
[METC-8450-T2-VOL-1] p0707 N80-31912	performance
RADIATIVE EECOBBINATION  Pefficiency of grantus-ntilizing color energy	P0769 A80-48394 BRACTION KINETICS
Efficiency of quantum-utilizing solar energy converters in the presence of recombination losses	The kinetics of the 02/C02 reaction in molten
p0610 A80-46953	carbonate - Reaction orders for O2 and CO2 on BiO
RADIO ASTROBORT	in fuel cells
Workshop on Satellite Power Systems (SPS) Effects	p0726 180-48284
on Optical and Radio Astronomy	The MARK-13 process for hydrogen production
[CONF-7905143] p0643 N80-31435	p0662 A80-48412
BADIO PREQUENCIES	Reaction modelling and correlation for flash
Conceptual design of RST: An rf-driven,	hydropyrolysis of lignite
steady-state Tokamak	p0678 A80-48433
[EPRI-AP-1351] p0751 880-32233	A hybrid water-splitting cycle using copper
RADIO FREQUENCY HEATING	sulfate and mixed copper oxides
Transport code simulations of lower hybrid heating	p0664 A80-48503
in tokamaks	Qualitative and quantitative assessment of
p0719 A80-44664	reaction models of coal hydrogenation
	p0679 A80-49629

SUBJECT IBDEK RECYCLISG

Evaluation of high temperature LiAl/TiS2 cells p0773 A80-50508	REACTOR TECHNOLOGY The Tandem Mirror Fusion Test Pacility
Kinetics and mechanisms of catalytic hydroliquefaction and hydrogasification of lignite	p0720 A80-45850 Advanced power technology for fusion reactors
[PR-2702-8] p0691 N80-28555 Investigation of mechanisms of hydrogen transfer	p0728 A80-48359 TRACT -A small fusion reactor based on near-term
in coal hydrogenation [PB-2305-33] p0697 H80-29517	engineering p0733 A80-48493
Alloy catalysts with monolith supports for methanation of coal-derived gases	DOB authorization, 1981, volume 2 [GPO-61-774-VOL-2] p0581 880-30224
[FE-2729-8] p0699 H80-30541 Liquid fuels from biomass: Catalysts and reaction	Assessment of the US Mirror Pusion program.  Report of the 1980 Mirror Senior Review Panel
conditions [LBL-9789] p0705 N80-31646	[DOE/ER-0057] p0748 B80-31214 Gasification of coal with solar energy
Kinetics and mechanisms of catalytic hydroliquefaction and hydrogasification of lignite	[UCRL-84458] p0643 H80-31652
[PE-2702-10] p0709 N80-32556 ACTION PRODUCTS	A multi-site magnetotelluric measurement system with real time data analysis
Ultrasonic characterization of coal liquefaction products	P0714 H80-33988
[DOE/PC-10346/1] p0702 N80-31503	Evaluation of line focus solar central power systems. Volume 1: Executive summary
The SNIAS magnetic bearing wheel	[ATR-80 (7773-03)-1-VOL-1] p0648 N80-31943
[SELAS-792-421-101] p0775 M80-28929 Passive radially centered magnetic suspension for	Solar central receiver hybrid power systems sodium-cooled receiver concept. Volume 1:
high velocity rotors	Executive summary
[SNIAS-792-422-109] p0775 N80-28930	[ DOB/ET-20567/1-1] p0648 N80-31948 The 3x Compound Parabolic Concentrating (CPC)
CT-6 tokamak research - Development and test	solar energy collector
operation of the experimental device p0718 A80-44343	[DOE/CS-04239/T1] p0655 N80-32944 RECOMBINATION REACTIONS
Design of the HTGR for process heat applications	Theory of polycrystalline silicon solar cells -
p0758 A80-48313 Blanket options for high-efficiency fusion power	Effect of reduction in grain boundary recombination states
p0729 A80-48360 The fusion-synfuel tie producing bydrogen with the	RECOVERABLE SPACECRAFT
Tandem Birror Reactor p0662 A80-48403	SPS salvage and disposal alternatives [NASA-CE-161548] p0641 N80-30898
Interfacing the Tandem Mirror Reactor to the	RECRYSTALLIZATION Thin film polycrystalline silicon solar cells
sulfur-iodine process for hydrogen production p0662 A80-48404	[SAN-2207-T4] p0638 N80-29879
Development of a falling-bed fusion blanket system for synthetic fuel production	Peasibility of siting SPS rectennas over the sea
p0678 A80-48447 Bigh-temperature thermochemical water splitting	p0623 A80-50955 Solar power satellite offshore rectenna study
cycle fusion reactor design considerations p0663 A80-48449	[NASA-CR-161543] p0759 N80-30891 Satellite Power Systems (SPS) concept definition
Energy conversion considerations of the STARFIRE connectial fusion power plant	study. Volume 5: Special emphasis studies rectenna and solar power satellite design studies
p0733 A80-48490 The Engineering Test Facility - The next major	[NASA-CR-3322] p0651 N80-32861 RECYCLING
development in the U.S.A. fusion program p0733 A80-48491	Selecting fines recycle methods to optimize fluid bed combustor performance
The reversed-field pinch fusion reactor p0733 180-48492	p0671 A80-48169 Recycling World Congress, 2nd, Manila,
TRACT -A small fusion reactor based on near-term engineering	Philippines, march 19-22, 1979, Proceedings p0678 A80-49537
p0733 A60-48493	Recycling Berlin '79; Proceedings of the
The Spheromak fusion reactor	International Congress, Berlin, West Germany, October 1-3, 1979. Volumes 1 6 2
An engineering development plan for inertial confinement fusion	p0680 A80-49926
p0733 A80-48496 Liquid-phase methanol	p0680 A80-49927 State and tendencies of recycling in North America
[EPRI-AF-1291] p0692 H80-28567 Advanced coal gasification system for electric	p0573 A80-49929 The efficiency of recovering energy and materials
power generation [FE-1514-97] p0700 B80-30548	from solid waste p0574 A80-49933
Molten salt coal gasification process development unit	The conversion of refuse into energy within a regional context
[SAB-1429-52] p0700 B80-30554 Thermionic energy conversion. Citations from the	p0680 A80-49938 Potential for conversion of refuse to energy in
NTIS data base [PB80-810906] p0747 B80-30953	Ontario Canada and the Provincial Energy from Waste program
Magnetohydrodynamic generators in power generation. Citations from the HTIS data base	p0681 A80-49946 Refuse incineration - A recycling process
[PB80-810856] p0748 N80-30954	p0681 A80-49955
Conceptual design of RST: An rf-driven, steady-state Tokamak	Recycling of effluents and organic residues into methane by anaerobic digestion - New perspectives
[EPRI-AP-1351] p0751 N80-32233	p0683 A80-49995 The production of substitute natural gas and
BACTOR MATERIALS  Blanket options for high-efficiency fusion power	recyclables from municipal solid waste
p0729 A80-48360 Materials considerations for the coupling of	p0683 A80-49996 Energy recycling through refuse pelletizing
<ul> <li>thermochemical hydrogen cycles to tandem mirror reactors</li> </ul>	p0683 A80-50008 Assumptions and ground rules used in nuclear waste
p0662 A80-48405 Materials technology for ccal-conversion processes	projections and source term data [ONWI-24] p0585 N80-32203
[ANI-80-12] p0700 B80-30551	Fants 241

REDUCTION (CHRMISTRY)		Relativistic-electron-beam/target i	nteraction in
Structures, reduction potentials and absorption maxima of synthetic dyes of interest in		plasma channels	p0735 A80-4906
photochemical solar-energy storage studies p0595 A80-4	4531Á	<pre>Hagnetic-pressure acceleration of c liners by the pulse generators fo</pre>	
Aqueous trifluoromethanesulfonic acid fuel cells	5	electron beams	
[AD-A086579] p0745 M80-3 Low-cost solar array project and Proceedings of		LIABILITY AHALYSIS	p0736 A80-4909
the 15th Project Integration Meeting		Application of battery reconditioni	
[NASA-CR-163568] p0650 N80-3	32852	to achieve capacity restoration Ni-Cd cell performance improv	
Development of new catalysts for coal liquids refining		spacecraft applications	p0769 A80-4839
[PE-2595] p0691 H80-2	28553	Safety studies on Li/SO2 cells. IV	- hoves won-4033
Refinery energy profile [ORO-5262-5-SUPPL] p0577 B80-2	28857	Investigations of alternate organ for improved safety	ic electrolytes
Refining and upgrading of synfuels from coal and	đ .		p0737 A80~5050
oil shales by advanced catalytic processes [PE-2315-48] p0703 N80-3		LIABILITY ENGINEERING Interim status report on DOE protot	ype development
Catalyst characterization in coal liquefaction [SAND-80-0123] p0709 N80-3	32560	SEECS Small Wind Energy Conve	
Development of new catalysts for coal liquid		Safety studies on Li/SO2 cells. V -	
refining [PE-2595-5] p0710 #80-3	32569	design variables on the abuse res hermetic D cells	istance of
REPLECTORS	,		p0737 A80-5050
Bigh concentration solar collector of the steppe spherical type - Optical design characteristic		Design and development of Stirling stationary power applications in.	the 500 to 3000
p0629 A80-5 National solar optical materials program plan:		hp range. Subtask 1A report: St conceptual design	ate-of-the-art
overview :		[DOE/ET-15209/T1]	p0744 B80-3075
[SERI/TP-641-619] p0639 #80-2 An evaluation of spectrally selective reflectors		MOTE CONTROL Instrumentation and process control	development
(cold mirror membranes) for use with concentrator solar arrays		for in situ coal gasification [SAND-80-0482]	p0692 N80-2856
p0659 #80-3	33900 RE	MOTE REGIONS	•
BREPRACTORY MATERIALS  Blanket options for high-efficiency fusion power	• •	Development of a 4 kW wind turbine	generator p0725 180-4826
p0729 A80-4 Chemical and physical stability of refractories		Analysis of small, nonconventional	electric power
for use in coal gasification		systems for remote site applicati	p0765 A80-4827
[COO-2904-15] p0690 H80-2 Haterials technology for ccal-conversion process		Simple economic evaluation and appl experiments for photovoltaic syst	
[ANL-80-12] p0700 w80-3 Design, engineering and evaluation of refractory	30551	sites	
liners for slagging gasifiers	RE	[SAND-80-0749C] HOTRLY PILOTED VEHICLES	p0655 N80-3293
[IITRI-M6043-5] p0704 880-3 REPRIGERATING MACHINERY	31640	Bickel-zinc batteries for aircraft applications	and aerospace
Absorption refrigeration machine driven by solar	•		p0772 180-4848
heat [EUR-6748-EN] p0646 N80-3	31914	<pre>Nickel-zinc batteries for RPV appli [AD-A088594]</pre>	p0780 N80-3390
REPRIGERATORS Analysis of a heat-activated Stirling heat pump	RE	SEARCE AND DEVELOPMENT OTEC research in Japan	
p0730 A80-4	18424	•	p0718 A80-4460
The feasibility of pellet re-fuelling of a fusion	a a	Progress in the field of terrestria generators	•
reactor p0719 A80-4	14661	Research issues for low cost photov	. p0602 A80-4671 oltaic cells
REGREERATION (ENGINEERING)			p0605 A80-4674
Regenerative engines with dense phase working fluids - The Malone cycle		Operational characteristics of a 60 photovoltaic system integrated wi	
p0734 180-4 Regenerative flywheel energy storage system	48502	The case for fuel-cell-powered vehi	p0609 180-4679
[UCBL-13982-BEV-1] p0775 N80-2	28884		p0721 A80-4710
REGENERATIVE FURL CRLLS  Electrochemical Orbital Energy Storage (ECOES)		The design, application benefits, a energy-efficient motors - A techn	na economics of ological update
technology program regenerative fuel cell system		Advanced battery development at Gen	p0571 180-4759
p0780 m80-3	33473		p0764 A80-4823
REGENERATORS A packed bed dehumidifier/regenerator for solar		The direction and scope of the U.S. Energy's surface coal gasificatio	
air conditioning with liquid desiccants p0595 A80-4	15312	Interim status report on DOE protot	p0672 \A80-4824
REGIONAL PLANNING		SWECS Small Wind Energy Conve	rsion Systems
Wind energy planning - Development and application of a site selection method for wind energy	ion	The challenge of financing geothern	p0726 A80-4827 al development
conversion systems /WECS/	44676	The MOD-2 wind turbine	p0727 A80-4831
The conversion of refuse into energy within a	770/0		-p0727 A80-4832
regional context p0680 180-4	49938	Development of a compressed air ene power generation plant - The PSPC	
REINFORCED PLATES		plant study	• • •
Rotating strength of laminated composite discs p0762 A80-4	47454	Characterization of a potential und	p0767 180-4833 erground coal
RELATIVISTIC ELECTRON BRAMS  Grad B focusing and deposition of relativistic		gasification site in the State of	
electron beams	12072	Potential economics of large space	
p0717 A80-4	+37/2	power stations	n0617 A80-4835

SUBJECT INDEX REVERSE FIELD PINCE

Sandia battery program for energy storage in photovoltaic systems Temperature-induced permeability alterations in unconsolidated and consolidated aquifer media --- for seasonal thermal energy storage
p0766 & 80-48336 p0767 A80-48368 Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program The design of photovoltaic systems for residential applications in the United States p0677 A80-48428 Exxon Donor Solvent Coal Liquefaction Process -D0602 A80-46716 Development Program Status Residential photovoltaic systems p0677 A80-48430 D0615 A80-48228 Bickel hydrogen battery advanced development program status report Development of a 4 kW wind turbine generator P0725 A80-48269 Alternative metering practices. Implicationservation in multifamily residences [HCP/H1693-03] p05 p0770 A80-48439 Implications for Progress in the development of small flame heated thermionic energy converters p0579 N80-29838 RESIDENTIAL BRERGY An engineering development plan for inertial confinement fusion National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings p0626 A80-52826 p0733 A80-48496 Operation and maintenance cost data for Lead-acid traction batteries for electric road residential photovoltaic modules/panels [WASA-CE-163585] p065 vehicle propulsion Directions for research and [NASA-CE-163585] p0650 #80-32855 Theory and design of an Annual Cycle Energy System development D0772 A80-48766 (ACES) for residences
[OBML/COM-43] p0587 M80-32904

Economic evaluation of the Annual Cycle Energy
System (ACES). Volume 1: Executive summary
[ORML/SUB-7470/1-41] p0587 M80-32905

Development of an 8 kW wind turbine generator for Solar thermal electric power systems in Japan P0620 A80-48916 Future aviation fuels - The petroleum industry responds to the challenge [SAE PAPER 800769] p0680 A80-49713 Potential for conversion of refuse to energy in residential type application. Phase 1: Design Ontario Canada and the Provincial Energy from and analysis. Volume 1: Executive summary [DOE/DP-03533/T1-VOL-1] p0753 88 Waste program p0681 A80-49946 p0753 N80-32957 A refuse incineration plant in combination with district heating demonstrated by the Iserlohn Design package for solar domestic hot water system
[NASA-CR-161558] p0657 N80-338 p0657 N80-33867 Low-cost flywheel demonstration program [CONS-5085-T2] p0 P0681 A80-49964 p0780 N80-33909 · RESIDUAL GAS Recent developments in a slagging process for conversion of refuse to energy Cogeneration Technology Alternatives Study (CTAS).
Volume 6: Computer data. Part 2:
Residual-fired nocogeneration process boiler
[NASA-CR-159770-PT-2] p0591 N80-3386 Increased information acquisition and transmission as a condition for the further development of p0591 N80-33861 energy economy structures RESISTANCE HEATING p0575 A80-50826 Joule heating effects in the electrode wall boundary layer of MHD generators Use of geothermal energy in the eastern United p0743 N80-29620 States p0685 A80-50908 Ocean thermal energy conversion contribution to the energy needs of the United States Steps to system analysis in waste management p0574 A80-49932 P0737 A80-50909 Application of the energy concept to a resource Peasibility of siting SPS rectennas over the sea recovery system p0574 A80-49934 P0623 A80-50955 Solar opportunities - Domestic and international Energy models as a tool for planning p0625 A80-51951 p0577 A80-54035 TIDP - Basic research for answering Plorida's Puels research: Puel thermal stability overview p0694 880-29324 residential energy conservation questions The global 2000 report to the president. Entering the twenty-first century. Volume 2: The P0576 A80-51954 Research, development, and commercialization activities on biomass energy in the United States the twenty-first century. Volume 2: technical report --- trends in population, climate, gross national product, earth resources, technology, and man environment interactions p0687 A80-52857
Photovoltaic solar energy conversion; Proceedings
of the Conference, London, England, September 28, 1979 p0782 N80-32296 p0628 A80-52860 Assessment of Peruvian biofuel resources and The extraterrestrial imperative. III - New alternatives earth-space energy metabolism. I [ANL/EES/TH-86] p0708 N80-32547 p0688 A80-53323 RETORT PROCESSING Heat and mass transfer processes during the Tidal energy and the energy crisis - An assessment of technology and the interrelationship pyrolysis of antrim oil shale [ASME PAPER 80-HT-123] p0671 A80-48039 p0689 A80-53682 The Cold Water Pipe - Ocean engineering status and Solar retorting of oil shale p0613 A80-48198 developments p0740 A80-53684 RETROPITTIES Closed cycle MHD power plant and retrofit optimization application Small Wind Turbine Systems 1979: A Workshop on R and D Requirements and Utility Interface/Institutional Issues. p0717 A80-44231 Volume 1: R and D requirements Solar heating and donestic hot water system installed at North Dallas High School [NASA-CR-161482] p0 [RFP-3014-VOL-1] p0747 N80-30943 Basic research needs and priorities in solar energy. Volume 1: Inecutive summary. Technology crosscuts for DOB [SEB1/TR-351-358-VOL-1] p0645 B6 [NASA-CR-161482] p0634 880-29847 Evaluation of the Ram-Jet device, a PCV air bleed p0582 N80-30964
District heating and cooling systems for communities through power statements. p0645 N80-31898 communities through power plant retrofit distribution network, volume 4 RESEARCE PACILITIES Experimental design for Hydraulic Transport
Research Pacility [COO-4977/1-VOL-4] p0753 N80-32942 p0759 N80-29629 [PB-3274-1] REVERSE PIELD PIECE The reversed-field pinch fusion reactor RESERVOTES p0733 A80-48492 The Pederal Geothernal Energy Program p0723 A80-48182

RIGID STRUCTURES SUBJECT INDEX

RIGID STRUCTURES		ROTORS	wind operan
Dynamics and control of a continuum model f solar power system	.UE a	Review of the current status of the innovative systems projects	aing energy
[AIAA 80-1740] p0757	A80-45534	[SERI/TP-635-469]	p0694 B80-28892
RING CORRESTS	.an1+a	Static investigation of rotor blades	at rest and
CT-6 tokamak research. II - Experimental re	A80-46670	under quasi-stationary loading	p0747 N80-30948
RISEBS		BUBY LASEBS	
Material evaluation and testing program for riser cable	OTEC	Improvement of phosphorus diffused si	ilicon solar
	180-48351	cells by laser treatment	p0606 A80-46763
RIVER BASINS		RUTHRHIUM COMPOUNDS	
. gvaluation of hydropower potential in a riv	er basin	Man-made molecular assemblies for ene	
Prediction analysis technique	N80-33856	conversion from light into chemical	p0661 A80-46271
ROADS			
Peasibility of alternatives for surface		<b>S</b>	
utilization of coal wastes [FE-3105-1] p0692	N80-28563	SAFETY	•
BOCKET ENGINES	_	Study of gelled LMG characterizat	
A study of the applicability/compatibility inertial energy storage systems to future		LNG with respect to process, flow, properties, and safety	use
missions	space	[DOB/EV-02057/T2]	p0695 N80-29506
	N80-32856	SALIBITY	•
Environmental effects of space systems - A	TAVIAN	Salton Sea solar pond project	p0617 A80-48362
	A80-46880	SALTOB SEA (CA)	POUL 200 40302
ROCKS	•	Salton Sea solar pond project	
Air/rock storage for solar central receiver stations		SALTS	p0617 A80-48362
	A80-48196	Thermal energy storage using Glauber	's salt -
ROOPS		Improved storage capacity with then	
Roof overhang design for solar control [CONF-791022-15] p0632	N80-28900	Heat storage capability of a rolling	p0764 180-48197 cvlinder
ROTARY STABILITY		using Glauber's salt	•
Turbulence as experienced by a moving rotor wind turbine	of a		p0773 A80-50945
	A80-48320	Thermal energy storage using saturate solutions	eu sait
Field experiences with rotordynamic instabi	lity in		p0774 A80-51125
high-performance turbomachinery oil a natural gas recovery	nd	An investigation of the thermal energy capacity of Glauber's salt with res	
	N80-29707	thermal cycling	spect to
Stability and dynamic response to gravitati			p0774 A80-51683
forces of the flapping and lead-lag hinge rigid rotor blade with the leading-edge a		Energy storage as heat-of-fusion in c salts. Report on energy storage bo	
attack and flapping being coupled			p0777 N80-32862
	N80-30949	SANDS	4
ROTATING BODIES  The sun-mill - A version of dunking-bird as	an .	High temperature thermal energy store and sand	ige in steel
energy convertor of sun's radiation			p0776 N80-29860
p0596 ROTATING CYLINDERS	A80-45459	SANDWICH STRUCTURES	lation of
Heat storage capability of a rolling cylind	er	Study of sandwich type glass encapsul solar cells	Lation of
using Glauber's salt			p0602 A80-46714
P07/3. ROTATING DISKS	A80-50945	The SNIAS magnetic bearing wheel	
Rotating strength of laminated composite di	scs	[SNIAS-792-421-101]	p0775 N80-28929
	A80-47454	SATELLITE DESIGN	
ROTATION  Composite rotor blades for large wind energy	<b>1V</b>	Environmental protection of the solar satellite	c bower
installations			p0609 A80-46899
[NASA-TM-75822] p0749 ROTOR AERODYNAMICS	N80-31881	Computer simulation of solar panel vo	oltage
The aerodynamics of contra-rotating axial f	low		p0612 A80-48177
wind power turbines	**** 330C0	Electrical power subsystem for INSAT-	
[CSIR-ME-1638] p0755	N80-33868	Satellite Power Systems (SPS) concept	p0616 A80-48308
Turbulence as experienced by a moving rotor	of a	study. Volume 5: Special emphasis	
wind turbine	100-00330	rectenna and solar power satellite	
ROTOR BLADES (TURBONACHINERY)	A80-48320	[NASA-CE-3322] SATELLITE GROUND SUPPORT	p0651, N80-32861
Low cost composite materials for wind energ		Satellite Power Systems (SPS) concept	
conversion systems	A80-44104	study. Volume 5: Special emphasis rectenna and solar power satellite	
Experimental investigation of systems for	400 44104	[NASA-CR-3322]	p0651 N80-32861
diminishing the structural loads of large	wind	SATELLITE POWER TRANSMISSION (TO EARTH)	
turbines . p0722	A80-47600	Effects of microwave beams on the ion	osphere p0757 A80-46881
Performance of a low cost cross-wind-axis		Solar power satellites - The present	
sail-wind turbine	100-51120		p0757 180-47562
FU/38 Wind commercialization and Alcoa Vertical A	180-51124 Xis	Materials-related design issues in the central receiver pilot plant	. sotel
Wind Turbines		• •	p0623 A80-50800
p0687 Large wind turbine generator performance as	A80-52868 sessment	The first realistic solar energy pro-	ject p0758
	N80-31960	Satellite Power Systems (SPS) concept	
-		study. Volume 6: In-depth element	

SUBJECT IBDEE SCHOTTKY DIODES

Satellite power system (SPS) concept definition study. Volume 3: Experimental verification Satellite Power Systems (SPS): Concept development and evaluation program: Preliminary study. Voldefinition assessment [ NASA-CB-3320 ] p0651 N80-32860 [ NASA-TH-81142] Satellite Power Systems (SPS) concept definition study. Volume 5: Special emphasis studies ---rectenna and solar power satellite design studies Selection of alternative central-station technologies for the Satellite Power System (SPS) comparative assessment [ WASA-CR-3322] p0651 880-32861 [DOE/ER-0052] p0580 N80-29887 Satellite power systems: Status and planned Some guestions and answers about the Satellite activities Power System (SPS) [NASA-CB-163329] p0760 N80-33904 p0639 N80-29897 Satellite Power System (SPS) FY 79 program summary [NASA-CR-163479] p0639 N80-29900 Solar power satellite offshore rectenna study SATELLITE SOLAR EBERGY CONVERSION Progress in space power technology p0722 A80-48173 Bigh-efficiency concentration/multi-solar-cell [ NASA-CR-161543 ] P0759 N80-30891 [MASA-CR-161543] p0759 M60-30898
[NASA-CR-161548] p0641 N80-30898
Satellite Power Systems (SPS) concept definition
study. Volume 7: System/Subsystem requirements system for orbital power generation Solar thermophotovoltaic space power system P0614 A80-48208 Concentrating photovoltaics - A viable candidate for the next generation of Air Porce satellite power systems data book [NASA-CR-3324] p0759 N80-30900
Satellite power systems (SPS) concept definition
study. Volume 1: Executive summary study. Volume 1: Executive summary p0759 M80-30901 (NASA-CR-3317) p0759 M80-30901 (Comparative assessment of environmental welfare issues associated with the Satellite Power p0614 A80-48209 Concentrator-enhanced photovoltaic arrays for deep space applications p0614 A80-48210 Design and flight performance of the Pioneer Venus System (SPS) and alternative technologies Multiprobe and Orbiter solar arrays [DOB/BB-0055] p0581 N80-30915 Comparative analysis of net energy balance for p0614 A80-48212 Insat-I solar array - Design and development summary Satellite Power Systems (SPS) and other energy systems p0615 A80-48213 Large area flexible solar array design for Space [DOE/RR-0056] p0582 N80-30916 Workshop on Satellite Power Systems (SPS) Effects Shuttle application on Optical and Radio Astronomy
[CONP-7905143]
Satellite power systems (SPS) concept definition
study. Volume 2, part 1: System engineering
[NASA-CR-3318]
p0760 N80-31890 D0615 A80-48214 High voltage power systems for military needs --solar energy conversion equipment p0725 A80-48254 The photoklystron --- for satellite solar energy Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative conversion p0623 A80-50956 Satellite Power Systems (SPS) concept definition study. Volume 7: System/Subsystem requirements data book technologies [ NASA-CR- 163049 ] p0750 N80-31951 SATELLITE TRANSMISSION data book [NASA-CR-3324] p0759 N80-30900 Satellite power systems (SPS) concept definition study. Volume 1: Executive summary [NASA-CR-3317] p0759 N80-30001 Climate and con-Solar power satellites - The ionospheric connection 470-kW photovoltaic power system for Saudi Arabia villages Climate and energy: A comparative assessment of the Satellite Power System (SPS) and alternative energy technologies
[DOE/ER-0050] p0581 N80-30914
Workshop on Satellite Power Systems (SPS) Effects SCALE MODELS
DAM-ATOLL - A system for extracting energy from ocean waves p0740 A80-53679 on Optical and Radio Astronomy [CONF-7905143] p0643 880-31435 Mean wind forces on parabolic-trough solar Satellite Power Systems (SPS) cost review collectors [ DOE/TIC-11190 ] p0654 N80-32928 [SAND-80-7023] p0650 N80-32790 Satellite power systems: Status and planned SCALING LAWS activities Particle confinement scaling experiments in the Culham Levitron D0760 N80-33904 SATELLITE SOLAR POWER STATIOUS Dynamics and control of a continuum model for a SCHOTTEY DIODES solar power system [AIAA 80-1740] Economic requirements for new materials for solar photovoltaic cells p0757 A80-45534 The potential global market in 2025 for Satellite Solar Power Stations p0596 A80-45317 Conduction in sputtered a-Si-H Schottky-barrier p0598 A80-46382 solar cells p0598 A80-46475 Scaling and the start-up phase of space industrialization Oxide semiconductors in photoelectrochemical P0598 A80-46386 conversion of solar energy An environmental assessment of the satellite power p0599 &80-46568 Degradation effects in silicon Schottky barrier system reference design p0757 A80-46396 solar cells Photovoltaic power generators in space p0601 A80-46709 P0604 A80-46735 Schottky barriers on sputtered hydrogenated amorphous silicon - Photovoltaic properties and Environmental effects of space systems - A review p0757 A80-46880 capacitance-voltage characteristics p0602 A80-46720 Photocell heat engine solar power systems p0612 A80-48179 Contact formation, scaling and optimisation of large-area R.F. sputtered a-Si Schottky barrier The SPS concept - An overview of status and outlook · Satellite Power System p0617 A80-48353 D0602 A80-46721 Satellite power systems for Western Europe -Problems and solution proposals The stability of amorphous silicon Schottky-barrier solar cells p0602 480-46722 p0622 A80-50633 Feasibility of siting SPS rectennas over the sea On the influence of an interfacial oxide layer on Au/n-Gals Schottky barrier solar cells p0608 A80-46784

SCRAP	Survey of semiconductor combinations for optimum
A method to reclaim metallic material and energy	heterojunction thin film solar cells
from automobiles p0684 A80-50024	p0605 A80-46753 Integrated Cu2S-CdS thin film solar cell generator
SEA STATES	p0606 A80-46770
South Atlantic OCS physical oceanography, volume 2	Optical and calorimetric measurements of cupreous
monitoring ocean currents and sea states to assess effects of oil and gas activities on the	sulphides thin films for solar cells p0607 A80-46779
environment	Photoelectrochemical investigation on trigonal
[PB80-181555] p0562 N80-31026	selenium film electrodes
South Atlantic OCS physical oceanography, volume 3 monitoring ocean currents and sea states to	p0610 A80~47139 SEMICORDUCTOR DEVICES
assess the environment effects of oil and gas	Comprehensive explanation of efficiency limits in
activities	silicon solar cells
[PB80-181563] p0583 N80-31027	p0600 A80-46697
SEA NATER The mist-lift OTEC cycle	Theoretical performance of multi-layer grid patterns for solar cells
p0718 A80-44602	p0605 A80-46752
A scheme for large scale desalination of sea water	Limiting efficiencies of ideal single and multiple
by solar energy p0595 A80-45313	energy gap terrestrial solar cells p0609 A80-46951
DAM-ATOLL - A system for extracting energy from	Metallic thermoelectric materials in solar
ocean waves	· thermoelectric generators
p0740 180-53679	p0610 A80-47152
SEALERS Collector sealants and breathing	Design of a thermophotocell p0610 A80-47154
[DOE/CS-15362/1] p0650 N80-32527	Biological solar cell
SEALS (STOPPERS)	[SERI/TP-623-656] p0639 880-29893
Ceramic dome receiver technology developments p0619 A80-48466	SENICOHDUCTOR JUNCTIONS
Utilization of low temperature insulators and	High-efficiency InP homojunction solar cells p0598 A80-46496
seals in thermionic converters	A new diffusion process for silicon solar cells
p0732 A80-48474	p0601 A80-46708
SEAWEEDS Kelp processing and biomethanation technology	Interface recombination and junction field studies in the Cu2S-CdS solar cell
p0673 A80-48278	p0603 A80-46724
Kelp farm and OTEC-1 upwelling pipes	CdTe homojunctions solar cells
p0740 A80-53675 SEEBECK EPPECT	p0603 A80-46731  High efficiency transcells and vertical
Thermoelectric properties of bismuth-antimony thin	multijunction cells for double-sided
films for energy conversion	concentrated illumination
p0729 180-48391	p0606 180-46768
SRISHIC EMERGY  Energy programs at the Johns Hopkins University	Photon loss analysis and design of thin-film planar function Cu2S/CdS devices
Applied Physics Laboratory	p0607 A80-46776
[PB80-195316] p0783 880-33919	Efficient Gals shallow-homojunction solar cells on
SELECTIVE DISSEMINATION OF INFORMATION Proceedings of the Ocean Energy Information	single-crystal Gals and Ge substrates p0608 180-46783
Dissemination Workshop	I-V relationship for the Cu2S/CdS solar cell
[SERI/TP-732-600] p0753 #80-32956	p0609 A80-46937
SELBHIDES Photoelectrochemical solar cells based on d-band	Theoretical investigations into collection coefficient for Cu/2-1/5-CdS cells with
electrochemistry at transition metal diselemides	allowance for surface states at interface
[IS-4724] p0648 B80-31952	p0610 A80-47151
SELEBION Selenium heterostructure solar cells	Photovoltaic conversion - Recent progress in solid state solar cells
p0598 A80-46259	p0620 A80-48790
Photoelectrochemical investigation on trigonal	SEMICOMDUCTORS (MATERIALS)
selenium film electrodes	Structure of anorphous silicon and silicon hydrides
Emerging materials systems for solar cell	p0599 A80-46647 Progress on the Dow Corning process for
applications: Cu/sub 2-x/Se	solar-grade silicon
[DOB/ET-23005/T3] p0632 B80-28895	p0600 A80-46699
SELF DIFFUSIOE (SOLID STATE) A high volume process for silicon solar cells	Potential for improved silicon ribbon growth through thermal environment control
using solid diffusion sources	p0601 A80-46704
p0601 A80-46707	Thermoelectricity - Phase diagrams and
SEMICOHDUCTING FILES  The spectral response of CdS:Cu/x/S solar cells	imperfection structures. II p0731 A80-48434
formed by dry barrier techniques	Photo-intercalation - Possible application in
p0597 A80-46251	solar energy devices
Solar energy conversion using CdSe photoelectrochemical cells with low cost	p0620 A80-48548 Photoreduction of carbon dioxide and water into
substrates	formaldehyde and methanol on semiconductor
p0597 A80-46253	materials
MIS and SIS solar cells on polycrystalline silicon p0597 A00-46257	p0621 A80-48923 Bodels for the photoelectrolytic decomposition of
Conduction in sputtered a-Si-H Schottky-barrier	water at semiconducting oxide anodes
solar cells	p0664 A80-50512
p0598 A80-46475 Photovoltaic Solar Energy Conference, 2nd, Berlin,	Emerging materials systems for solar cell applications: Cu/sub 2-x/Se
West Germany, April 23-26, 1979, Proceedings	[DOE/ET-23005/T3] p0632 B80-28895
p0600 A80-46694	SEESITIVITY
Ion implanted solar cells from EPG silicon ribbons	Optimum OTEC design and sensitivity analysis using
Epitaxial Pilm Growth p0601 A80-46705	geometric programming p0741 A80-53688
Progress in the development of the thin film #IS	Fo 100 30000
solar cell based on CdSe	
p0603 A80-46728	•

SUBJECT INDEX SILICON

•	·
	·
SEPARATED PLOW  Sites for wind-power installations: Wind	Environmental data energy technology characteristics: Synthetic fuels
characteristics over ridges, part 2	[DOE/EV-0073] p0579 N80-29516
[RLO-2438-78/2] p0706 N80-31901	Combustion studies of coal-in-oil droplets
SRPARATORS	[DOE/ET-10660/1] p0702 N80-31499
Cycle life studies of Lial/PeS cells using BM felt separators	Economics of shale oil production by radio frequency heating
p0763 A80-48189	[UCRL-52942] p0710 N80-32566
Power production from geothermal brine with the	Synthetic fuels from US oil shales: A technical
rotary separator turbine p0725 A80-48266	and economic verification of the HY10RT process [DOB/RT-14102/3] p0710 N80-32567
New separator materials for nickel-cadmium	New method to determine the independent shear
aircraft batteries	moduli of transversely isotropic materials
p0772 180-48484	[COMF-800575-1] p0712 N80-32796 SHEAR PROPERTIES
Alternative process schemes for coal conversion [BNI-51117] p0692 N80-28560	New method to determine the independent shear
SEQUENCING	moduli of transversely isotropic materials
A preliminary 'test case' manufacturing sequence	[CONF-800575-1] p0712 880-32796 SHOCK FRONTS
for 50 cents/watt solar photovoltaic modules in 1986	The operating region of MHD generators
p0607 A80-46771	p0739 A80-51721
SERVICE LIFE	SHORT CIRCUITS
Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data	Short circuit current in indium tin oxide/silicon solar cells
analysis	p0622 A80-50752
p0761 A80-46414	SHROUDED TURBINES
Physical/chemical modeling for photovoltaic module life prediction	Preliminary results from the shrouded wind-turbine pilot plant
p0608 A80-46790	p0722 A80-47525
Cycle life studies of Likl/FeS cells using BN felt	SILICATES Properties of a solar alumina-borosilicate sheet
separators p0763 180-48189	glass
Optimization studies of lithium/iron sulfide cells	[SERI/TP-334-565] p0641 N80-30530
for electric vehicle applications p0763 180-48190	SILICON  The influence of grain size and dopant
Development of a tubular lithium-iron sulfide cell p0763 k80-48192	concentration on the electrical properties of polycrystalline silicon films
Scaling up of bipolar lithium/iron disulfide cells	P0600 A80-46696
p0763 A80-48193 Effect of positive pulse charge waveforms on cycle	Comprehensive explanation of efficiency limits in silicon solar cells
life of nickel-zinc cells	p0600 A80-46697
p0766 A80-48329	Technology and economics of starting materials for low-cost silicon solar cells
Design, performance and life cycle cost relationships for a 500kW space solar array	p0600 A80-46698
p0617 A80-48356	Progress on the Dow Corning process for
Safety studies on Li/SO2 cells. V - Effect of design variables on the abuse resistance of	solar-grade silicon p0600 180-46699
hermetic D cells	Early assessment of the photovoltaic
p0737_A80-50509	potentialities of RAD polysilicon sheets
Oxygen electrodes for energy conversion and storage [DOE/ET-25502/1] p0753 N80-32878	p0600 A80-46701 Low cost crystalline silicon for solar cells
[DOE/ET-25502/1] pu/53 N80-328/8 SBWAGE	p0600 A80-46703
Energy savings in a rotary kiln in the production	Potential for improved silicon ribbon growth
of cement through the addition of domestic waste and sewage sludge	through thermal environment control p0601 A80-46704
P0574 A80-49958	Ion implanted solar cells from RPG silicon ribbons
SENAGE TREATMENT	Epitaxial Film Growth
Biogasification of municipal waste p0683 180-49997	p0601 A80-46705 A new diffusion process for silicon solar cells
The Wetox process for energy recovery from sewage	p0601 A80-46708
sludge and industrial waste streams p0683 A80-49998	Degradation effects in silicon Schottky barrier solar cells
Power generation from municipal and industrial	p0601 A80-46709
wastes with particular reference to sewage	Effect of laser irradiation on the characteristics
Combustion p0685 A80-50815	of implanted layers for silicon solar cells p0602 180-46711
SHADES	Schottky barriers on sputtered hydrogenated
Roof overhang design for solar control [CONF-791022-15] p0632 N80-28900	amorphous silicon - Photovoltaic properties and capacitance-voltage characteristics
SHALE OIL	p0602 A80-46720
Heat and mass transfer processes during the	Contact formation, scaling and optimisation of
pyrolysis of antrim oil shale [ASME PAPEE 80-HI-123] p0671 A80-48039	large-area R.F. sputtered a-Si Schottky barrier solar-cells
Solar retorting of oil shale	p0602 A80-46721
p0613 A80-48198	The stability of amorphous silicon Schottky-barrier solar cells
D.C. electrical conductivity of Green River oil Shales	p0602 A80-46722
p0685 A80-50278	Some characteristics of low-cost silicon sheet
The utilisation of oil shale and lignite as low grade fuels in a cyclone furnace	p0605 180-46756  LOW Cost processes for silicon fabricated for
p0685 A80-50963	solar cells
Alternative Gas Workshop	p0606 A80-46757
[LA-8155-C] p0690 N80-28547 Refining and upgrading of synfuels from coal and	Rlectrowinning of silicon from K2SiP6-molten fluoride systems
oil shales by advanced catalytic processes	p0622 A80-50510
[PE-2315-40] p0691 N80-28550 Hilitary jet fuel from shale oil	n-CdS/p-Si heterojunction solar cells p0626 A80-52498

p0694 N80-29308

SILICOE CARBIDES SUBJECT IEDEX

Low cost solar cells based on amorphous silicon	Some electric and photoelectric properties of
electrodeposited from organic solvents [SAN-0113-040-T7] p0637 N80-29873	photodetectors based on epitaxial layers Si/x/Ge/1-x/ with diffused p-n junction
Low-cost solar array project and Proceedings of	p0610 A80-4715
the 15th Project Integration Meeting [MASA-CR-163568] p0650 M80-32852	Amorphous silicon solar cells p0622 A80-5062
Study program for encapsulation materials	Open-circuit voltage of induced-junction solar cell
interface for low cost silicon solar array	p0622 180-5075
[NASA-CR-163583] p0651 H80-32857 Deposition, fabrication and analysis of	Photoelectrochemistry with p-Si electrodes - Bffects of inversion
polycrystalline silicon MIS solar cells	p0737 180-5076
[DOE/ET-23044/4] p0653 #80-32920	Temperature effects in silicon solar cells
Amorphous thin films for sclar-cell applications [DOB/ET-21074/4] p0653 M80-32921	p0624 A80-5111 SILVER ZIEC BATTERIES
Investigation of the impurity tolerance of	Cycles till failure of silver-zinc cells with
semicrystalline silicon solar cells silicon impact program	competing failure modes - Preliminary data analysis
[DOE/CH-00178/T2] p0654 N80-32934	p0761 A80-4641
Thin, high efficiency silicon solar cells 56 micrometers thick	SILVICULTURE The potential of energy farming for transport
p0658 N80-33885	fuels in New Zealand
Qualification test results of the production high	[PB80-154248] p0693 H80-2857
efficiency K6-3/4 and K7 silicon solar cells p0658 N80-33886	The potential of energy farming for transport fuels in New Zealand, appendices
Radiation damage in high voltage silicon solar cells	[PB80-154255] p0693 N80-2857
p0658 B80-33889 Comparison of silicon solar cell characteristics	SIMILARITY THEOREM Similarity theory of solar water heater with
at operating temperature after electron	natural circulation
irradiation	p0621 180-4891
p0659 N80-33890 SILICON CARBIDES	SIEGLE CEYSTALS  Efficient GaAs shallow-homojunction solar cells on
Ceramic done receiver technology developments	single-crystal Gals and Ge substrates
p0619 A80-48466 Combustion performance of CVD silicon carbide	p0608 A80-4678 Current status of growth processes for solar grade
thermionic diodes Chemical Vapor Deposition	silicon
p0732 A80-48473 SILICON COMPCUNDS	puezu Aeu-4878
Structure of amorphous silicon and silicon hydrides	Research on Cu sub x S/(cd, Zn)S photovoltaic solar energy converters
p0599 A80-46647	[LBL-10791] p0654 N80-3292
Low cost solar cells based on amorphous silicon electrodeposited from organic solvents	SINTERING Processes to increase utilization of power solid
[SAH-0113-040-T6] p0648 N80-31953	vastes
SILICON DIOXIDE Progress on the Dow Corning process for	[ISM-245] p0702 M80-3092 The fluidized bed gasification of coal char
solar-grade silicon	[BLL-RTS-12346] p0712 H80-3357
p0600 A80-46699 stlicom Pilms	SIS (SEBICOBDUCTORS) MIS and SIS solar cells on polycrystalline silicon
MIS and SIS solar cells on polycrystalline silicon	p0597 A80-4625
p0597 A80-46257 Theory of polycrystalline silicon solar cells -	SITE SELECTION
Effect of reduction in grain boundary	Peasibility of siting SFS rectennas over the sea p0623 A80-5095
recombination states	Siting handbook for small wind energy conversion
p0597 A80-46258 Photovoltaic Solar Energy Conference, 2nd, Berlin,	systems [PNL-2521-REV-1] p0747 M80-3094
West Germany, April 23-26, 1979, Proceedings	Sites for wind-power installations: Physical
p0600 180-46694 Low-cost, high-efficiency silicon by heat	modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.
exchanger method and fixed abrasive slicing	Part 1: Executive summary
technique for solar cells	[BLO-2438-78/1] p0706 N80-3190
p0600 A80-46700 Current status of growth processes for solar grade	Sites for wind-power installations: Wind characteristics over ridges, part 2
silicon	[RLO-2438-78/2] p0706 B80-3190
p0620 A80-48789 Photovoltaic conversion - Recent progress in solid	Summary of guidelines for siting wind turbine generators relative to small-scale,
state solar cells	two-dimensional terrain features
p0620 A80-48790 Amorphous silicon solar cells	[BLO-2443-77/1] p0647 BBO-3193 Bnvironmental implications of electric utility
p0628 A80-52863	supply plans, 1978-2000
Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879	[PB80-192156] p0588 N80-3296
SILICON JUNCTIONS POSSU NOG-29079	Wind energy planning - Development and application
A multiple p-n junction structure obtained from	of a site selection method for wind energy
as-grown Czochralski silicon crystals by heat treatment - Application to solar cells	conversion systems /WBCS/ p0719 A80-4467
p0595 A80-45121	Environmental data for sites in the National Solar
Production of photovoltaic devices [ASME PAPER 79-SOL-8] p0596 A80-45662	Data Network [SOLAB/0010-80/02] p0649 N80-3197
Experimental optimization of the efficiency of	SLAGS
n/+/-p-p/+/ and p/+/-n-n/+/ silicon solar cells p0601 A80-46706	Recent developments in a slagging process for
A high volume process for silicon solar cells	conversion of refuse to energy p0682 A80-4998
using solid diffusion sources	Design, engineering and evaluation of refractory
p0601 A80-46707  Byaluation of multijunction structures using	liners for slagging gasifiers [IITRI-M6043-5] p0704 H80-3164
amorphous Si-Ge alloys for solar cells	Condensation processes in coal combustion products
p0602 A80-46719 Radiation effects on solar cells	[DOE/EE-10456/1] p0708 N80-3247
p0609 180-46894	

SUBJECT INDEX SOLAR ARRAYS

·	
LUDGE New directions in energy recovery from petroleum	20 kW gallium arsenide photovoltaic dense array for central receiver concentrator applications
refinery oily sludges p0685 A80-50034	p0608 A80-46793 Description of photovoltaic village power systems
LOBRIES	in the United States and Africa
generation using coal/oil fuel	p0609 A80-46796 Photovoltaic systems design and performance
p0724 A80-48225	for commercial applications
Heat transfer in slurry preheaters for coal liquefaction plants	p0611 A80-47597 Computer simulation of solar panel voltage
p0678 A80-48432	regulation -0612 100 mos27
Thermophysical properties of coal liquids [BMI-2043] p0701 N80-30557	p0612 A80-48177 The applicability of DOE solar cell and array
Performance of a diesel engine operating on raw coal-diesel fuel and solvent refined coal-diesel	technology to space power p0613 A80-48206
fuel slurries	Concentrator-enhanced photovoltaic arrays for deep
[CONS-3288-T6] p0701 N80-30758	space applications
Application of the lime/limestone flue gas	Heat-rejection design for large concentrating
desulfurization process to smelter gases p0576 A80-53084	solar arrays p0614 A80-48211
OCIAL PACTORS	Design and flight performance of the Pioneer Venus
Social acceptance of energy systems - Some	multiprobe and Orbiter solar arrays
observations on the situation in the Third World	p0614 A80-48212
p0572 A80-49025 Ensured power supply and environmental protection	Insat-I solar array - Design and development summary
as elements of a provident social policy	Large area flexible solar array design for Space
p0575 A80-50825 Costing methodologies for energy systems	Shuttle application p0615 A80-48214
[BNL-27603] p0778 N80-32900	Intermediate load-center photovoltaic application
OCIOLOGY Technology Assessment. Citations from the NTIS	experiments p0615 A80-48230
data base	A six kilowatt transformer-coupled converter for
[PB80-813165] p0783 N80-34299 Technology Assessment. Citations from the NTIS	Space Shuttle solar power systems p0616 A80-48262
data base	Electrical power subsystem for INSAT-I
[PB80-813173] p0783 N80-34300	p0616 A80-48308
ODIUM CHLORIDES  A new rechargeable high voltage low temperature	Mission analysis of the P78-2 power subsystem after one year of operation
molten salt cell	p0765 A80-48310
p0764 A80-48237 · ODIUE COOLIEG	Multi-hundred kW solar arrays for space p0617 A80-48355
Alternative configurations for sodium-cooled solar thermal power plants	Design, performance and life cycle cost relationships for a 500kW space solar array
p0625 A80-52075	p0617 A80-48356
ODIUS HITBATES Investigation of nitrate salts for solar latent	Silicon solar cell array technology and the prospects for cost reduction
heat storage p0595 A80-45316	p0628 A80-52861 Conceptual design study of concentrator enhanced
ODIUE SULFATES	solar arrays for space applications. 2kW Si and
Thermal energy storage using Glauber's salt - Improved storage capacity with thermal cycling	Gals systems at 1 MU [NASA-CR-163046] p0630 N80-28863
p0764 A80-48197	Satellite Power Systems (SPS) concept definition
ODIUS SULFUR BATTERIES Advanced battery development at General Electric	study. Volume 7: System/Subsystem requirements data book
p0764 A80-48234	[NASA-CR-3324] p0759 N80-30900
Sodium-sulfur load leveling battery system p0764 A80-48235	Photovoltaic module electrical termination design requirement study
Volume optimization of sodium-sulfur batteries	[JPL-955367-80/1] p0644 N80-31877
using various advanced cell concepts	Low-cost solar array project and Proceedings of
p0764 A80-48236 A new rechargeable high Voltage low temperature	the 15th Project Integration Meeting [NASA-CR-163568] p0650 N80-32852
molten salt cell	A computer model of solar panel-plasma interactions
p0764 A80-48237 Sodium-sulfur-aluminum chloride cells	[NASA-CR-160796] p0650 N80-32853 Operation and maintenance cost data for
p0764 A80-48238	residential photovoltaic modules/panels
Resistance rise in sodium-sulphur cells p0774 A80-51698	[NASA-CR-163585] p0650 N80-32855 Study program for encapsulation materials
Development of sodium sulfur batteries	interface for low cost silicon solar array
[BHFT-FB-T-79-60] p0776 N80-29905 DIAB ARRAYS	[NASA-CR-163583] p0651 M80-32857 Satellite Power Systems (SPS) concept definition
Progress in the field of terrestrial solar	study. Volume 6: In-depth element investigation
generators p0602 180-46713	[NASA-CR-3323] p0651 N80-32859 Satellite power system (SPS) concept definition
Study of sandwich type glass encapsulation of	study. Volume 3: Experimental verification
solar cells p0602 A80-46714	definition [NASA-CB-3320] p0651 N80-32860
A low cost solar simulator for testing	[NASA-CR-3320] p0651 N80-32860 Gallium arsenide photovoltaic dense array for
photovoltaic terrestrial solar power cells and	concentrator applications
modules p0604 180-46738	[SAND-80-1569C] p0654 #80-32936 Large solar arrays
Dc to ac power conditioning for photovoltaic	p0657 #80-33471
arrays and utility interfacing p0605 A80-46744	Electrochemical Orbital Energy Storage (ECOES) technology program regenerative fuel cell
Recent developments in the economic modeling of	system
-batamaltaiadmla manufacturing	
photovoltaic module manufacturing	p0780 N80-33473
p0607 A80-46773	

SOLAR CRILIS SUBJECT INDEX

Potential use of terrestrial photovoltaics for Effect of laser irradiation on the characteristics of implanted layers for silicon solar cells future space solar arrays p0602 A80-46711 p0658 N80-33882 Efficient thermal cycling of solar panels in solar simulation facilities with a multi-panel test rig Study of sandwich type glass encapsulation --- of solar cells p0659 N80-33898 p0602 A80-46714 Optimization studies of materials in hydrogenated An evaluation of spectrally selective reflectors (cold mirror membranes) for use with concentrator solar arrays amorphous silicon solar cells p0602 A80-46717 p0659 N80-33900 Evaluation of multijunction structures using amorphous Si-Ge alloys --- for solar cells SOLAR CELLS A proposed slotted mask for direct deposition of p0602 A80-46719 metal contact pattern on MIS solar cells Schottky barriers on sputtered hydrogenated amorphous silicon - Photovoltaic properties and p0595 A80-45119 A multiple p-n junction structure obtained from as-grown Czochralski silicon crystals by heat treatment - Application to solar cells capacitance-voltage characteristics p0602 A80-46720 Contact formation, scaling and optimisation of large-area R.P. sputtered a-Si Schottky barrier p0595 A80-45121 Economic requirements for new materials for solar solar-cells photovoltaic cells p0602 A80-46721 The stability of amorphous silicon Schottky-barrier solar cells p0596 A80-45317 Production of photovoltaic devices
[ASME PAPER 79-SOL-8] p0596 A80The spectral response of CdS:Cu/x/S solar cells p0596 A80-45662 p0602 A80-46722 Interface recombination and junction field studies formed by dry barrier techniques in the Cu2S-CdS solar cell p0597 A80-46251 EBIC and capacitance measurements on Cu2S-cds solar cells - Stability problems --- Electron Beam Induced Current A solar thermophotovoltaic converter D0597 180-46256 MIS and SIS solar cells on polycrystalline silicon p0597 A80-46257 p0603 A80-46725 Theory of polycrystalline silicon solar cells -Effect of reduction in grain boundary Optimal material properties for CdS/Cu2S solar cells p0603 A80-46726 recombination states Thin film /CdZn/S for solar cells p0603 A80-46727 p0597 A80-46258 Selenium heterostructure solar cells Progress in the development of the thin film MIS solar cell based on CdSe p0598 A80-46259 Conduction in sputtered a-Si-H Schottky-barrier D0603 A80-46728 solar cells Photoelectrochemical solar cells p0603 A80-46730 p0598 A80-46475 High-efficiency InP homojunction solar cells CdTe homojunctions solar cells p0598 A80-46496 p0603 A80-46731 Photovoltaic Solar Energy Conference, 2nd, Ber. West Germany, April 23-26, 1979, Proceedings 2nd, Berlin, Concentration and temperature performances of Gals-Gallas solar cells P0600 A80-46694 p0603 A80-46734 New experimental evidence for minority carrier MIS diodes --- for solar cells Photovoltaic power generators in space p0604 A80-46735 D0600 A80-46695 Pulsed measurement of solar cell spectral response The influence of grain size and dopant F0604 A80-46737 concentration on the electrical properties of A low cost solar simulator for testing polycrystalline silicon films photovoltaic terrestrial solar power cells and p0600 A80-46696 modules P0604 A80-46738 Comprehensive explanation of efficiency limits in Photovoltaic generators using optical concentration silicon solar cells p0600 A80-46697 p0604 A80-46739 Technology and economics of starting materials for Operation of multi-bandgap concentrator cells with low-cost silicon solar cells a spectrum splitting filter --- photovoltaic D0600 A80-46698 conversion efficiency Progress on the Dow Corning process for p0604 A80-46740 solar-grade silicon Solar cells with concentrating collectors and p0600 A80-46699 integrated heat use system Low-cost, high-efficiency silicon by heat exchanger method and fixed abrasive slicing p0604 A80-46742 Research issues for low cost photovoltaic cells technique --- for solar cells p0605 A80-46748 p0600 A80-46700 Numerical modelling of a solar cell in three Early assessment of the photovoltaic potentialities of RAD polysilicon sheets dimensions p0605 A80-46749 P0600 A80-46701 Theoretical performance of multi-layer grid Low cost crystalline silicon --- for solar cells p0600 A80-46703 patterns for solar cells p0605 A80-46752 Survey of semiconductor combinations for optimum Ion implanted solar cells from EPG silicon ribbons Epitaxial Film Growth heterojunction thin film solar cells p0605 A80-46753 p0601 A80-46705 Experimental optimization of the efficiency of n/+/-p-r/+/ and p/+/-n-n/+/ silicon solar cells Semiconductor-electrolyte solar cells for the photoelectrochemical reduction of carbon dioxide p0601 A80-46706 to organic fuel A high volume process for silicon solar cells using solid diffusion sources p0605 A80-46755 Some characteristics of low-cost silicon sheet p0601 A80-46707 p0605 A80-46756 A new diffusion process for silicon solar cells p0601 A80-46708 Degradation effects in silicon Schottky barrier Low cost processes for silicon --- fabricated for solar cells p0606 A80-46757 On the effects of boron and phosphorus primary p0601 A80-46709 impurities in p-type silicon material for solar Advanced thin silicon solar cell with controlled optical absorptance --- for space power systems cells p0606 A80-46758 Improvement of phosphorus diffused silicon solar and arrays p0601 A80-46710 cells by laser treatment D0606 A80-46763

SOBJECT INDEX SOLAR CELLS COETD

Influence of the double exponential on the efficiency and the yield of screen printed solar cells --- energy conversion effectiveness

p0606 A80-46764 A computer model for polycrystalline Si n/plus//p solar cells

p0606 A80-46766

High efficiency silicon solar cell for concentrator systems

p0606 A80-46767

High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination

p0606 A80-46768

Advances in theory, fabrication and applications of bifacial solar cells D0606 A80-46769

Integrated Cu2S-CdS thin film solar cell generator P0606 A80-46770

A preliminary 'test case' manufacturing sequence for 50 cents/watt solar photovoltaic modules in

p0607 A80-46771

Model for the photovoltaic effect in Cu2S-CdS solar cells in the backwall configuration P0607 A80-46775

Photon loss analysis and design of thin-film planar junction Cu2S/CdS devices

p0607 A80-46776 Optical and calorimetric measurements of cupreous sulphides thin films --- for solar cells

D0607 A80-46779 Preparation and analysis of Cu20 thin-film solar

p0607 A80-46781 Accurate computer analysis of solar cells

including band-gap variation - Application to the Al/x/Ga/1-x/AsGaAs structure D0607 A80-46782

Efficient Gals shallow-home junction solar cells on single-crystal GaAs and Ge substrates

p0608 A80-46783 On the influence of an interfacial oxide layer on Au/n-GaAs Schottky barrier solar cells

p0608 A80-46784 Alsb as a candidate material for photovoltaic

solar energy conversion

Determination of the spectral distribution of global radiation with a rapid spectral radiometer and its correlation with solar cell efficiency

p0608 A80-46789 Influence of meteorological conditions on the design of solar energy dc-ac inverters

p0609 A80-46795 Operational characteristics of a 60 kW photovoltaic system integrated with a utility grid p0609 A80-46797

Radiation effects on solar cells

p0609 A80-46894

Environmental protection of the solar power satellite

D0609 A80-46899 I-V relationship for the Cu2S/CdS solar cell p0609 A80-46937

Limiting efficiencies of ideal single and multiple energy gap terrestrial solar cells p0609 A80-46951

High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy p0610 A80-46952

Photoelectrochemical investigation on trigonal selenium film electrodes

p0610 A80-47139 Theoretical investigations into collection

coefficient for Cu/2-x/S-CdS cells with allowance for surface states at interface p0610 A80-47151

Solar cells for terrestrial applications p0611 A80-47156 Investigation of high-voltage heterophotoconverters

p0611 A80-47163 Surface passivation of inversion layer m.i.s. solar cells

p0612 A80-48150

Computer simulation of solar panel voltage regulation

D0612 A80-48177 GaAs solar cells for space applications

p0613 A80-48203 Effects of thermal annealing on the deep-level defects and I-V characteristics of 200 keV proton irradiated AlGaAs-GaAs solar cells

p0613 A80-48204 The planar multijunction cell - A new solar cell for earth and space

p0613 A80-48205 The applicability of DOE solar cell and array

technology to space power p0613 A80-48206

High-efficiency concentration/multi-solar-cell system for orbital power generation

p0614 A80-48207 Solar thermophotovoltaic space power system p0614 A80-48208

Concentrating photovoltaics - A viable candidate for the next generation of Air Force satellite pover systems .

p0614 A80-48209 Concentrator-enhanced photovoltaic arrays for deep space applications

D0614 A80-48210 Heat-rejection design for large concentrating

solar arravs p0614 A80-48211 Design and flight performance of the Pioneer Venus

Multiprobe and Orbiter solar arrays p0614 A80-48212 Insat-I solar array - Design and development summary

p0615 A80-48213 Large area flexible solar array design for Space Shuttle application

p0615 A80-48214

The 100-kWp photovoltaic power system at Natural Bridges National Monument

p0615 A80-48227 Residential photovoltaic systems costs p0615 A80-48229

Intermediate load-center photovoltaic application experiments

p0615 A80-48230 Photovoltaic central station applications - Status

and prospects p0615 A80-48231

470-kw photovoltaic power system for Saudi Arabia villages p0616 A80-48232

High performance photovoltaic systems p0616 A80-48233

Electrical power system for the SBS communication satellite

p0617 A80-48309 Thin film solar cells

p0619 A80-48513 Photo-intercalation - Possible application in solar energy devices

p0620 A80-48548 Current status of growth processes for solar grade

p0620 A80-48789 Photovoltaic conversion - Recent progress in solid

state solar cells Photoreduction of carbon dioxide and water into

formaldehyde and methanol on semiconductor materials

Optimized grid patterns for Cu2S-CdS solar cells p0621 A80-49322 Electrowinning of silicon from K2SiF6-molten

fluoride systems p0622 A80-50510

Amorphous silicon solar cells

p0622 A80-50625

Concentrators and solar photovoltaics

solar cells.

p0622 A80-50626 Theoretical analysis of new wavelength-division solar cells

p0622 A80-50745 Short circuit current in indium tin oxide/silicon

p0622 A80-50752 Open-circuit voltage of induced-junction solar cells p0622 180-50758 SOLAR COLLECTORS SUBJECT INDEX

Degradation of solar cell performance by areal inhomogeneity	Amorphous thin films for solar-cell applications [DOB/ET-21074/4] p0653 B80-32921
p0624 A80-51112 Temperature effects in silicon solar cells	Satellite Power Systems (SPS) cost review [DOR/TIC-11190] p0654 N80-32928
p0624 A80-51115	Investigation of the impurity tolerance of
Distributed series resistance in photovoltaic devices - Intensity and loading effects	semicrystalline silicon solar cells silicon impact program
p0624 A80-51118 Dimensionless groupings for photovoltaic	[DOB/CH-00178/T2] p0654 H80-32934 Gallium arsenide photovoltaic dense array for
performance analysis p0624 A80-51463	concentrator applications [SAND-80-1569C] p0654 B80-32936
Predicted effect of grid line aspect ratio on the	Simple economic evaluation and applications
performance of solar cells p0625 A80-51687	experiments for photovoltaic systems for remote sites
n-CdS/p-Si heterojunction solar cells p0626 A80-52498	[SAND-80-0749C] p0655 N80-32937 Concentrating photovoltaics for the tropics
Silicon solar cell array technology and the	[DOE/CS-04270/1] p0656 N80-32954
prospects for cost reduction p0628 A80-52861	Air Porce space power technology program p0782 N80-33468
Thin film currous sulphide-cadmium sulphide solar cells	Photovoltaic technology development for synchronous orbit
p0628 A80-52862	p0657 N80-33470
Amorphous silicon solar cells p0628 A80-52863	Potential use of terrestrial photovoltaics for future space solar arrays
Gallium arsenide solar cells for use in concentrated sunlight	p0658 N80-33882 Aspects of large area and thin silicon solar cell
p0628 A80-52864	technologies
Photovoltaics in the U.S.A A progress report p0629 A80-52866	p0658 N80-33884 Thin, high efficiency silicon solar cells 56
Coplanar back contacts for thin silicon solar cells [NASA-CR-159811] p0630 N80-28860	micrometers thick p0658 N80-33885
Silicon web process development	Qualification test results of the production high
[NASA-CE-163386] p0631 N80-28864 Boorging materials systems for solar cell	efficiency K6-3/4 and K7 silicon solar cells p0658 N80-33886
applications: Cu/sub 2-x/Se [DOB/ET-23005/T3] p0632 N80-28895	Development of space-qualified Gals solar cells p0658 N80-33888
Low-cost photovoltaic cell mount study	Radiation damage in high voltage silicon solar cells
[SAND-80-7006] p0633 N80-28908 Induced junction solar cell and method of	p0658 N80-33889 Comparison of silicon solar cell characteristics
fabrication [NASA-CASE-NPO-13786-1] p0634 N80-29835	at operating temperature after electron irradiation
Low cost solar cells based on amorphous silicon	p0659 N80-33890
electrodeposited from organic solvents	Impact of terrestrial solar cell development on
[SAN-0113-040-T7] p0637 N80-29873	space applications
Biological solar cell	p0659 N80-33893
Biological solar cell [SERI/TP-623-656] p0639 N80-29893 Overview of thick-film technology as applied to	p0659 N80-33893 SOLAR COLLECTORS Hydrogen and oxygen from water. III - Evaluation
Biological solar cell [SERI/TP-623-656] p0639 N80-29893 Overview of thick-film technology as applied to solar cells [SERI/TP-331-541] p0639 N80-29895	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298
Biological solar cell [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell	p0659 N80-33893 SOLAR COLLECTORS Hydrogen and oxygen from water. III - Evaluation of a hybrid process
Biological solar cell [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell [BMFT-FB-T-79-72] p0640 N80-29907	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications
Biological solar cell  [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell  [BMFT-FB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water
Biological solar cell [SERI/TP-623-656] p0639 N80-29893 Overview of thick-film technology as applied to solar cells [SERI/TP-331-541] p0639 N80-29895 Development of a cadmium selenide thin film solar cell [BMFT-PB-T-79-72] p0640 N80-29907 Controlled cadmium telluride thin films for solar	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313
Biological solar cell [SERI/TP-623-656] p0639 N80-29893 Overview of thick-film technology as applied to solar cells [SERI/TP-331-541] p0639 N80-29895 Development of a cadmium selenide thin film solar cell [BHFT-FB-T-79-72] p0640 N80-29907 Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications) [DOE/ET-23023/T3] p0642 N80-30921 Photovoltaic systems and applications perspective	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313  Evaluation of wall temperature difference profiles
Biological solar cell  [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell  [BMFT-PB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications)  [DOE/ET-23023/T3] p0642 N80-30921  Photovoltaic systems and applications perspective  [SAND-80-0926C]  Pilot line report: Development of a high	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation
Biological solar cell [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell [BMFT-FB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications) [DOE/ET-23023/T3] p0642 N80-30921 [DOE/ET-23023/T3] p0642 N80-30921 Photovoltaic systems and applications perspective [SAND-80-0926C] p0582 N80-30923 Pilot line report: Development of a high efficiency thin silicon solar cell [NASA-CR-163522] p0644 N80-31876	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  p0596 A80-45319  Beat exchanger effectiveness for solar collectors
Biological solar cell  [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell  [BMFT-PB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications)  [DOE/ET-23023/T3] p0642 N80-30921  Photovoltaic systems and applications perspective  [SAND-80-0926C]  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522] p0644 N80-31876  Satellite power systems (SPS) concept definition	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  P0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  P0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  P0596 A80-45319
Biological solar cell [SERI/TP-623-656] p0639 N80-29893 Overview of thick-film technology as applied to solar cells [SERI/TP-331-541] p0639 N80-29895 Development of a cadmium selenide thin film solar cell [BMFT-FB-T-79-72] p0640 N80-29907 Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications) [DOE/ET-23023/T3] p0642 N80-30921 Photovoltaic systems and applications perspective [SAND-80-0926C] p0582 N80-30923 Pilot line report: Development of a high efficiency thin silicon solar cell [NASA-CR-163522] p0644 N80-31876 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318]	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  P0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  P0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  P0596 A80-45319  Heat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings
Biological solar cell  [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell  [BMFT-FB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications)  [DOF/ET-23023/T3] p0642 N80-30921  Photovoltaic systems and applications perspective  [SAND-80-0926C] p0582 N80-30923  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522] p0644 N80-31876  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering  [NASA-CR-3318] Navanced photovoltaic concentrator cells  [DSE-4042-T40]	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  P0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  P0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  P0596 A80-45319  Heat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings  [ASHE PAPER 79-HT-18]  Convective-radiative interaction in a parallel
Biological solar cell  [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell  [BMFT-FB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications)  [DOE/ET-23023/T3] p0642 N80-30921  Photovoltaic systems and applications perspective  [SAND-80-0926C] p0582 N80-30923  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522] p0644 N80-31876  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering  [NASA-CR-3318] p0760 N80-31890  Advanced photovoltaic concentrator cells  [DSE-4042-T40] p0645 N80-31904  Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides	p0659 N80-33893  SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  p0596 A80-45319  Heat exchanger effectiveness for solar collectors  p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings [ASME PAPER 79-BT-18]  p0597 A80-45722
Biological solar cell  [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell  [BHFT-FB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications)  [DOF/ET-23023/T3] p0642 N80-30921  Photovoltaic systems and applications perspective  [SAND-80-0926C] p0582 N80-30923  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522] p0644 N80-31876  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering  [NASA-CR-3318] Nava-CR-3318]  Advanced pbotovoltaic concentrator cells  [DSE-4042-T40] p0645 N80-31504  Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides  [IS-4724] p0648 N80-31952	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  p0596 A80-45319  Heat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings  [ASHE PAPER 79-HT-18]  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors
Biological solar cell  [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell  [BMFT-PB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications)  [DOE/ET-23023/T3] p0642 N80-30921  Photovoltaic systems and applications perspective  [SAND-80-0926C]  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522] p0644 N80-31876  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering  [NASA-CR-3318] p0760 N80-31890  Advanced photovoltaic concentrator cells  [DSE-4042-T40] p0645 N80-31504  Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides  [IS-4724] p0648 N80-31952  Low cost solar cells based on amorphous silicon electrodeposited from organic solvents	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  P0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  P0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  P0596 A80-45319  Heat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings  [ASME PAPER 79-HT-18]  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  P0598 A80-46349  Generalization of the two-dimensional optical analysis of cylindrical concentrators
Biological solar cell [SERI/TP-623-656] p0639 N80-29893 Overview of thick-film technology as applied to solar cells [SERI/TP-331-541] p0639 N80-29895 Development of a cadmium selenide thin film solar cell [BMFT-FB-T-79-72] p0640 N80-29907 Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications) [DOE/ET-23023/T3] p0642 N80-30921 Photovoltaic systems and applications perspective [SAND-80-0926C] p0582 N80-30923 Pilot line report: Development of a high efficiency thin silicon solar cell [NASA-CR-163522] p0644 N80-31876 Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering [NASA-CR-3318] Advanced photovoltaic concentrator cells [DSE-4042-T40] p0645 N80-31890 Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides [IS-4724] Low cost solar cells based on amorphous silicon	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  p0596 A80-45319  Heat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings [ASME PAPER 79-HT-18] p0597 A80-45722  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Generalization of the two-dimensional optical
Biological solar cell  [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell  [BMFT-FB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications)  [DOE/ET-23023/T3] p0642 N80-30921  Photovoltaic systems and applications perspective  [SAND-80-0926C] p0582 N80-30923  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522] p0644 N80-31876  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering  [NASA-CR-3318] p0760 N80-31890  Advanced photovoltaic concentrator cells  [DSE-4042-T40] p0645 N80-31904  Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides  [IS-4724] p0648 N80-31952  Low cost solar cells based on amorphous silicon electrodeposited from organic solvents  [SAN-0113-040-T6] p0648 N80-31953  Gallium arsenide solar cells for very high concentration systems: Recent results, problems	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  p0596 A80-45319  Heat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings [ASME PAPER 79-HT-18] p0597 A80-45722  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Generalization of the two-dimensional optical analysis of cylindrical concentrators p0599 A80-46566  Total and non-isotropic diffuse insolation on tilted surfaces
Biological solar cell  [SERI/TP-623-656]  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541]  Development of a cadmium selenide thin film solar cell  [BMFT-FB-T-79-72]  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications (emerging materials systems for solar cell applications (emerging materials systems for solar cell applications perspective [SAND-80-0926C]  Piotovolaic systems and applications perspective [SAND-80-0926C]  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522]  Satellite power systems (SPS) concept definition study. Yolume 2, part 1: System engineering [NASA-CR-3318]  DO760 N80-31890  Advanced photovoltaic concentrator cells [DSE-4042-T40]  Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides [IS-4724]  Low cost solar cells based on amorphous silicon electrodeposited from organic solvents  [SAN-0113-040-T6]  Gallium arsenide solar cells for very high concentration systems: Recent results, problems and expectations  [CISE-1518]	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  P0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  P0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  P0596 A80-45319  Heat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings  [ASME PAPER 79-HT-18]  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  P0598 A80-46349  Generalization of the two-dimensional optical analysis of cylindrical concentrators  P0599 A80-46566  Total and non-isotropic diffuse insolation on tilted surfaces  P0599 A80-46571  Fluorescent planar concentrators - Performance and
Biological solar cell  [SERI/TP-623-656] p0639 N80-29893  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541] p0639 N80-29895  Development of a cadmium selenide thin film solar cell  [BHFT-FB-T-79-72] p0640 N80-29907  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications)  [DOF/ET-23023/T3] p0642 N80-30921  Photovoltaic systems and applications perspective  [SAND-80-0926C] p0582 N80-30923  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522] p0644 N80-31876  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering  [NASA-CR-3318] Naya-CR-3318] p0760 N80-31890  Advanced photovoltaic concentrator cells  [DSE-4042-T40] p0645 N80-31904  Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides  [IS-4724] Low cost solar cells based on amorphous silicon electrodeposited from organic solvents  [SAN-0113-040-T6] p0648 N80-31953  Gallium arsenide solar cells for very high concentration systems: Becent results, problems and expectations  [CISE-1518] p0649 N80-31962  Improving the efficiency of silicon solar cells containing chronium	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  P0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  P0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  P0596 A80-45319  Beat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings  [ASME PAPER 79-HT-18]  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  P0598 A80-46349  Generalization of the two-dimensional optical analysis of cylindrical concentrators  P0599 A80-46566  Total and non-isotropic diffuse insolation on tilted surfaces
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Biological solar cell  [SERI/TP-623-656]	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 &80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 &80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 &80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  p0596 &80-45319  Heat exchanger effectiveness for solar collectors p0596 &80-45320  Spectral effects on direct-insolation absorptance of five collector coatings [ASME PAPER 79-HT-18] p0597 &80-45722  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 &80-46349  Generalization of the two-dimensional optical analysis of cylindrical concentrators p0599 &80-46566  Total and non-isotropic diffuse insolation on tilted surfaces  p0599 &80-46571  Fluorescent planar concentrators - Performance and experimental results solar collector absorbing diffuse and direct radiation via fluorescent molecules  p0604 &80-46741  Solar cells with concentrating collectors and integrated heat use system
Biological solar cell  [SERI/TP-623-656]  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541]  Development of a cadmium selenide thin film solar cell  [BMFT-FB-T-79-72]  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications (emerging materials systems for solar cell applications)  [DOE/ET-23023/T3]  Photovoltaic systems and applications perspective  [SAND-80-0926C]  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522]  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering  [NASA-CR-3318]  Advanced photovoltaic concentrator cells  [DSE-4042-T40]  Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides  [IS-4724]  [SAN-0113-040-T6]  [SAN-0113-040-T6]  [CISE-1518]  Improving the efficiency of silicon solar cells containing chromium  [NASA-CRS-163568]  Improving the efficiency of silicon solar cells  containing chromium  [NASA-CRS-NPO-15179-1]  Low-cost solar array project and Proceedings of the 15th Project Integration Meeting  [NASA-CRS-163568]  Investigation of low-cost solar cells based on Cu20  [DOE/ET-23006/3]  CdSiAs2 thin films for solar cell applications	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  p0596 A80-45319  Heat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings  [ASHE PAPER 79-HT-18]  p0597 A80-45722  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Generalization of the two-dimensional optical analysis of cylindrical concentrators  p0599 A80-46566  Total and non-isotropic diffuse insolation on tilted surfaces  p0599 A80-46571  Pluorescent planar concentrators - Performance and experimental results solar collector absorbing diffuse and direct radiation via fluorescent nolecules  p0604 A80-46741  Solar cells with concentrating collectors and integrated heat use system
Biological solar cell  [SERI/TP-623-656]	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 &80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 &80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 &80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  p0596 &80-45319  Heat exchanger effectiveness for solar collectors p0596 &80-45320  Spectral effects on direct-insolation absorptance of five collector coatings [ASME PAPER 79-HT-18] p0597 &80-45722  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 &80-46349  Generalization of the two-dimensional optical analysis of cylindrical concentrators  p0599 &80-46566  Total and non-isotropic diffuse insolation on tilted surfaces  p0599 &80-46571  Pluorescent planar concentrators - Performance and experimental results solar collector absorbing diffuse and direct radiation via fluorescent molecules  p0604 &80-46741  Solar cells with concentrators for photovoltaics p0608 &80-46791  Irradiance on the receiver of a general optical
Biological solar cell  [SERI/TP-623-656]  Overview of thick-film technology as applied to solar cells  [SERI/TP-331-541]  Development of a cadmium selenide thin film solar cell  [BMFT-FB-T-79-72]  Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications)  [DOE/ET-23023/T3]  Photovoltaic systems and applications perspective  [SAND-80-0926C]  Pilot line report: Development of a high efficiency thin silicon solar cell  [NASA-CR-163522]  Satellite power systems (SPS) concept definition study. Volume 2, part 1: System engineering  [NASA-CR-3318]  Advanced photovoltaic concentrator cells  [DSE-4042-T40]  Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides  [IS-4724]  [SAN-0113-040-T6]  Gallium arsenide solar cells for very high concentration systems: Recent results, problems and expectations  [CISE-1518]  Improving the efficiency of silicon solar cells  containing chromium  [NASA-CASE-NPO-15179-1]  LOW-cost solar array project and Proceedings of the 15th Project Integration Meeting  [NASA-CR-163568]  Investigation of low-cost solar cells based on Cu20  [DOE/ET-23006/3]  CdSiAs2 thin films for solar cell applications	SOLAR COLLECTORS  Hydrogen and oxygen from water. III - Evaluation of a hybrid process  p0661 A80-45298  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  A scheme for large scale desalination of sea water by solar energy  p0595 A80-45313  Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation  p0596 A80-45319  Heat exchanger effectiveness for solar collectors p0596 A80-45320  Spectral effects on direct-insolation absorptance of five collector coatings  [ASHE PAPER 79-HT-18]  p0597 A80-45722  Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors  p0598 A80-46349  Generalization of the two-dimensional optical analysis of cylindrical concentrators  p0599 A80-46566  Total and non-isotropic diffuse insolation on tilted surfaces  p0599 A80-46571  Fluorescent planar concentrators - Performance and experimental results solar collector absorbing diffuse and direct radiation via fluorescent molecules  p0604 A80-46741  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-46791

SERIECT THREE SOLAR COLLECTORS COMED

Investigation of the service life of aluminum Simulation of a solar energy system by means of an mirrors on metal substrates at high temperatures electrical resistance network p0625 A80-51686 p0611 A80-47158 Photovoltaic systems design and performance ---Measurement of natural convection in air-cooled for commercial applications solar collectors p0627 A80-52834 Theoretical study of absorbed solar energy in Solar hot air balloons multi-layer absorber coatings for receivers of solar concentrators. II - Heat transfer analysis D0628 A80-52841 Hybrid thermal-photovoltaic systems p0612 A80-48034 [ASME PAPEE 80-HT-105] p0628 A80-52865 Thermal stress in a composite cylinder by finite DOE solar thermal power systems program p0629 A80-52869
High concentration solar collector of the stepped spherical type - Optical design characteristics difference technique --- solar concentrator tubular heat exchanger [ASBE PAPER 80-HT-107] p0612 A80-48036 p0629 A80-53263

Dynamic simulation and development of a control strategy for a distributed, concentrating solar A two-dimensional analysis of flat plate air-heating solar collectors
[ASME PAPER 80-HI-117] p0612 A80-High-efficiency concentration/multi-solar-cell p0612 A80-48038 collector field p0629 A80-53571 system for orbital power generation p0614 A80-48207 Liquid-metal MHD for solar and coal - System and Conceptual design study of concentrator enhanced solar arrays for space applications. 2kW Si and GaAs systems at 1 AU component status p0630 N80-28863 p0724 A80-48226 [ NASA-CR-163046] Plasma-sprayed coatings for very high temperature Sensitivity analysis of the value of a solar driven chemical heat pump system solar absorbers p0616 A80-48287 [CONF-791021-3] p0631 N80-28875 Analysis of the influence of geography and weather on parabolic trough solar collector design [SAND-79-2032] p0631 N80-288 Management of a large, operational solar pond p0617 A80-48363 p0631 N80-28876 Key questions in the application of salt-stratified solar ponds Effect of a heated atmosphere on the emittance of p0617 A80-48364 black chrome solar collector pipe surfaces p0631 N80-28877 Operational experience with a saturated borax [ OCRL-83506 ] solar pond Analysis of solar collector array systems using thermography [SERI/TR-351-494] p0617 A80-48365 p0632 N80-28894 Laboratory demonstration of self-creation, self-maintenance and self-correction of saturated solar ronds Roof overhang design for solar control [CONF-791022-15] p0632 N80-28900 Concentrating solar collector test results p0633 N80-28912 The JPL parabolic dish project --- solar [SAND-80-0801C] An investigation of wind loads on solar collectors [FB80-158744] p0633 N80-289 collectors technology development p0633 N80-28936 p0618 A80-48417 An investigation of wind loads on solar Thermal buffering of receivers for parabolic dish solar thermal power plants collectors. Appendix 1: Data, listing for top and bottom of collector D0618 A80-48419 [ PB80-158751] One megawatt /thermal/ bench model solar receiver design and test p0633 N80-28937. Automotive absorption air conditioner utilizing p0619 A80-48464 solar and motor waste heat [NASA-CASE-NPO-15183] Ceramic dome receiver technology developments p0619 A80-48466 p0634 N80-29843 Solar energy system performance evaluation: A comparison of the flat plate and concentrating Seasonal report for Contemporary Newman, Newman, solar collector Georgia [NASA-CE-161494] r0635 |
Solar energy system performance evaluation: £0635 N80-29853 p0619 A80-48507 The effect of direct and diffuse radiations on the thermal performance of flat-plate solar collectors Seasonal report for Fern Lansing, Lansing, p0620 A80-48793 Michigan The optimal interconnection of solar collectors in [NASA-CR-161491] p0635 N80-29855 air heating systems with large collector surfaces Solar energy system performance evaluation: p0620 A80-48794 Seasonal report for IBM System 1B, Carlsbad, New Similarity theory of solar water heater with Mexico p0635 N80-29856 [ NASA-CR-161508 ] natural circulation p0621 A80-48917 General formula for the incidence factor of a Urban solar photovoltaics potential: An inventor and modelling study applied to the San Fernando An inventory solar heliostat receiver system Valley region of Los Angeles [NASA-CR-163436] p0622 A80-49758 p0636 N80-29859 Development of a second generation concentrating Materials-related design issues in the solar central receiver pilot plant tracking solar collector p0623 A80-50800 [ ASE-4524 ] p0636 N80-29871 A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs Photovoltaic/thermal hybrid projects p0638 N80-29881 [BNL-27669] Survey of selective solar absorbers and their p0624 A80-50968 limitations
[SAND-79-2371C] Pressure loss in a spiral solar energy collector p0624 A80-50971 Synthesis of four bar linkages for solar tracking p0639 N80-29889 National solar optical materials program plan: An p0624 A80-51677 overview p0639 N80-29892 New reflector design which avoids losses through [SERI/TP-641-619] Summary of Solar Experience with the Soiling of gaps between tubular absorbers and reflectors
--- for solar collectors Optical Surfaces p0625 A80-51678 [SERI/TF-334-478] p0639 N80-29894 Properties of a solar alumina-borosilicate sheet Maximum solar flux concentration achievable with qlass axicon collectors [SERI/TP-334-565] p0641
Solar heating and domestic hot water system Ammonia/water absorption cycles with relatively installed at Kansas City, Fire Stations, Kansas high generator temperatures p0625 A80-51682 Solar radiation incident on tilted flat surfaces City, Missouri [NASA-CR-161513] p0641 N80-30895 in Barcelona, Spain Solar energy system performance evaluation report for IBM System 3, Glendo, Wyoming [NASA-CR-161520] p0641 N80-30

D0625 A80-51684

p0641 N80-30896

SOLAR COOLING SUBJECT INDEX

Pacific Missile Test Center energy projects.	Solar ponds and their applications
	Polar bonds and cherr abbitcactons
Summary of projects, contributions, and plans	[SERI/TP-733-617] p0655 N80-3294
[AD-A086196] p0581 N80-30903	Investigation of the feasibility of using wind
Performance estimates for attached sunspace	
	power for space heating in colder climates
passive solar heated buildings	[DOE/DP-03533/T3] p0753 #80-3295
[LA-UR-80-853] p0642 N80-30513	Self controlling, self pumping heat circulation
Hybrid photovoltaic/thermal systems with a	system study.
solar-assisted heat pump	[COO-4484-07] p0656 B80-3295
[BNI-27667] p0642 N80-30919	Solar passive systems for buildings
Solar energy system economic evaluation for	[PB80-187719] p0656 #80-3296
Elcam-Tempe, Tempe, Arizona and Elcam-San Diego,	Optimum systems design with random input and
San Diego, California	output applied to solar water heating
[NASA-CR-161492] p0644 N80-31672	p0657 N80-3385
Solar energy system performance evaluation:	Design data brochure for a pyramidal optical solar
Seasonal report for Colt Yosemite, Yosemite	system
National Park, California	[NASA-CR-161202] p0657 N80-3386
[NASA-CR-161539] p0645 N80-31883	Installation package for a sunspot cascade solar
Design, construction, and operation of a 150 kW	water heating system
solar-powered irrigation facility, phase 2	[NASA-CR-161562] p0657 N80-3386
[ALO-4159-1] p0645 N80-31903	Design package for solar domestic hot water system
Analytical prediction of liquid	[NASA-CR-161558] p0657 N80-3386
photovoltaic/thermal flat-plate collector	Cleaning agents and techniques for concentrating
performance :	
	sclar collectors
[COO-4094-66] p0646 N80-31913	[SAND-79-7052] p0659 N80-3391
Absorption refrigeration machine driven by solar	SOLAR COOLING
. heat	Working fluids for solar, Rankine-cycle cooling
[EUR-6748-EN] p0646 N80-31914	systems
Effect of circumsolar radiation on performance of	p0595 A80-4529
focusing collectors	A packed bed dehumidifier/regenerator for solar
[SERI/TR-34-093] p0646 N80-31916	air conditioning with liquid desiccants
Optical analysis of point focus parabolic	p0595 A80-4531
radiation concentrators	Solar cells with concentrating collectors and
[SEEI/TE-631-336] p0646 N80-31917	integrated heat use system
Dual curvature acoustically damped concentrating	p0604 A80-4674
collector	Investigation of temperature regime of
	single-story house with solar heating system
Field experience with solar concentrating	p0611 A80-4716
collector control systems	Solar/electric district heating via CASES
[SAND-79-2044C] p0647 N80-31924	Community Annual Storage Energy Systems
Analytical modeling of line focus solar collectors	p0616 A80-4828
[SEHI/TP-333-591] p0647 N80-31926	Sensitivity analysis of the value of a solar
Evaluation of control strategies for solar	driven chemical heat pump system
collector loops	p0616, A80-4828
[LBL-10716]   p0647 N80-31932	Engineering prototype studies on the CaCl2-CH3OH
Residential solar heating and cooling using	chemical heat pump for solar air conditioning,
evacuated tube solar collectors: CSU Solar	heating, and storage
House 3, executive summary	p0616 A80-4828
[COO-2858-24] p06A7 N80-31941	Test evaluation of a prototype 18-ton solar
Terrestrial photovoltaic power systems with	
	powered heating and cooling system
sunlight concentration	p0619 A80-4848
f C 3 ND - 0.0 7.0.0 2	
[SAND-80-7008] p0648 N80-31942	Optimum working fluids for solar powered Rankine
Evaluation of line focus solar central power	cycle cooling of buildings
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation	
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation	cycle cooling of buildings p0625 A80-5168
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] , p0648-880-31944	cycle cooling of buildings p0625 #80-5168 Solar powered absorption air conditioning
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] , p0648-N80-31944 Design of a cost effective sclar powered water pump	cycle cooling of buildings p0625 A80-5168 Solar powered absorption air conditioning p0629 A80-5347
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] p0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p0649 N80-31967	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning  p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] , p0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] , p0649 N80-31967 Environmental data for sites in the Bational Solar	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning  p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling  system
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] , p0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819]	cycle cooling of buildings  p0625 A80-5168 Solar powered absorption air conditioning p0629 A80-5347 Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] p0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p0649 N80-31967 Environmental data for sites in the National Solar Data Network [SOLAR/0010-80/02] p0649 N80-31975	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning  p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling  system
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] , p0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819]	cycle cooling of buildings  p0625 A80-5168 Solar powered absorption air conditioning p0629 A80-5347 Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80(7773-03)-1-VOL-2] , p0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] , p0649 N80-31967 Environmental data for sites in the Mational Solar Data Network [SOLAB/0010-80/02] , p0649 N80-31975 Collector sealants and breathing	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] p.0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967 Environmental data for sites in the Bational Solar Data Network [SOLAR/0010-80/02] p.0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2898
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 M80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p.0649 M80-31967 Environmental data for sites in the Bational Solar Data Network [SOLAB/0010-80/02] p.0649 M80-31975 Collector sealants and breathing [DOE/CS-15362/1] p.0650 M80-32527 Bean wind forces on parabolic-trough solar	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [D0E/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] , p0648 N80-31944  Design of a cost effective sclar powered water pump [PB80-182819] , p0649 N80-31967  Environmental data for sites in the Mational Solar Data Network [SOLAB/0010-80/02] , p0649 N80-31975  Collector sealants and breathing [DOE/CS-15362/1] , p0650 N80-32527  Bean wind forces on parabolic-trough solar collectors	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 M80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 M80-2989  Overview-absorption/Bankine solar cooling program [LEL-10770] p0640 M80-2990
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] , p0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770]  Solar thermal heating and cooling. A bibliography
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967 Environmental data for sites in the Bational Solar Data Network [SOLAB/0010-80/02] p.0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527 Hean wind forces on parabolic-trough solar collectors [SAND-80-7023] p.0650 N80-32790 Design and fabrication of combined	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Bankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2] , p0648 N80-31944  Design of a cost effective sclar powered water pump [PB80-182819]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Bankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967 Environmental data for sites in the Bational Solar Data Network [SOLAB/0010-80/02] p.0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527 Hean wind forces on parabolic-trough solar collectors [SAND-80-7023] p.0650 N80-32790 Design and fabrication of combined	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Bankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 N80-31944  Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967  Environmental data for sites in the Bational Solar  Data Network [SOLAR/0010-80/02] p.0649 N80-31975  Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527  Bean wind forces on parabolic-trough solar  collectors [SAND-80-7023] p.0650 N80-32790  Design and fabrication of combined photovoltaic-thermal collectors [SAND-79-7008] p.0652 N80-32890	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Bankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967 Environmental data for sites in the Bational Solar Data Network [SOLAR/0010-80/02] p.0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527 Bean wind forces on parabolic-trough solar collectors [SAND-80-7023] p.0650 N80-32790 Design and fabrication of combined photovoltaic-thermal collectors [SAND-79-7008] p.0652 N80-32890 Solar powered rankine cycle irrigation pump	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALD-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Bankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR BLECTRIC PROPULSIOB
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967 Environmental data for sites in the Bational Solar Data Network [SOLAR/0010-80/02] p.0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527 Hean wind forces on parabolic-trough solar collectors [SAND-80-7023] p.0650 N80-32790 Design and fabrication of combined photovoltaic-thermal collectors [SAND-79-7008] p.0652 N80-32690 Solar powered rankine cycle irrigation pump [DOE/CT-20419/1] p.0652 N80-32692 Pluid temperature control for parabolic trough solar collectors	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALD-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-2990  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR BLECTRIC PROPULSION Design and performance of the International
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p0649 N80-31967 Environmental data for sites in the Mational Solar Data Network [SOLAB/0010-80/02] p0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p0650 N80-32527 Hean wind forces on parabolic-trough solar collectors [SAND-80-7023] p0650 N80-32790 Design and fabrication of combined photovoltaic-thermal collectors [SAND-79-7008] p0652 N80-32890 Solar powered rankine cycle irrigation pump [DOE/ET-20419/1] p0552 N80-32892 Pluid temperature control for parabolic trough solar collectors [SAND-79-2006c] p0652 N80-32894	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR RIECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967 Environmental data for sites in the Bational Solar Data Network [SOLAR/0010-80/02] p.0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527 Hean wind forces on parabolic-trough solar collectors [SAND-80-7023] p.0650 N80-32790 Design and fabrication of combined photovoltaic-thermal collectors [SAND-79-7008] p.0652 N80-32690 Solar powered rankine cycle irrigation pump [DOE/CT-20419/1] p.0652 N80-32692 Pluid temperature control for parabolic trough solar collectors	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Bankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR BLECTRIC PROPULSIOB  Design and performance of the International Sun-Earth Explorer power systems
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p0649 N80-31967 Environmental data for sites in the Mational Solar Data Network [SOLAB/0010-80/02] p0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p0650 N80-32527 Hean wind forces on parabolic-trough solar collectors [SAND-80-7023] p0650 N80-32790 Design and fabrication of combined photovoltaic-thermal collectors [SAND-79-7008] p0652 N80-32890 Solar powered rankine cycle irrigation pump [DOE/ET-20419/1] p0552 N80-32892 Pluid temperature control for parabolic trough solar collectors [SAND-79-2006c] p0652 N80-32894	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR RIECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967 Environmental data for sites in the Bational Solar Data Network [SOLAR/0010-80/02] p.0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527 Hean wind forces on parabolic-trough solar collectors [SAND-80-7023] p.0650 N80-32790 Design and fabrication of combined photovoltaic-thermal collectors [SAND-79-7008] p.0652 N80-32890 Solar powered rankine cycle irrigation pump [DOE/ET-20419/1] p.0652 N80-32692 Fluid temperature control for parabolic trough solar collectors [SAND-79-2006c] p.0652 N80-32894 Parabolic trough solar collector wind loading [SAND-79-2134C] p.0652 N80-32895	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 R80-3196 Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR BLECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems  p0765 A80-4830  Electrical power system for the SBS communication
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 N80-31944  Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967  Environmental data for sites in the Mational Solar Data Network [SOLAB/0010-80/02] p.0649 N80-31975  Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527  Hean wind forces on parabolic-trough solar collectors [SAND-80-7023] p.0650 N80-32790  Design and fabrication of combined photovoltaic-thermal collectors [SAND-79-7008] p.0652 N80-32890  Solar powered rankine cycle irrigation pump [DOE/ET-20419/1] p.0652 N80-32692  Pluid temperature control for parabolic trough solar collectors [SAND-79-2006c] p.0652 N80-32894  Parabolic trough solar collector wind loading (SAND-79-2134C]  Pundamentals and techniques of nonimaging optics	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR RIECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Bankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR BLECTRIC PROPULSIOB  Design and performance of the International Sun-Earth Explorer power systems  p0765 A80-4830  Electrical power system for the SBS communication satellite
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2] p.0648 N80-31944 Design of a cost effective sclar powered water pump [PB80-182819] p.0649 N80-31967 Environmental data for sites in the Bational Solar Data Network [SOLAR/0010-80/02] p.0649 N80-31975 Collector sealants and breathing [DOE/CS-15362/1] p.0650 N80-32527 Hean wind forces on parabolic-trough solar collectors [SAND-80-7023] p.0650 N80-32790 Design and fabrication of combined photovoltaic-thermal collectors [SAND-79-7008] p.0652 N80-32890 Solar powered rankine cycle irrigation pump [DOE/ET-20419/1] p.0652 N80-32692 Pluid temperature control for parabolic trough solar collectors [SAND-79-2006c] p.0652 N80-32894 Parabolic trough solar collector wind loading [SAND-79-2134C] p.0652 N80-32895 Pundamentals and techniques of nonimaging optics for solar energy concentration [DOE/ER-04657/2] p.0652 N80-32896	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2899  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CB-163535] p0649 R80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite p0617 A80-4830
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSIOB  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Bankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CB-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR BLECTRIC PROPULSIOB  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2899  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CB-163535] p0649 R80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSIOB  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite  p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space p0599 A80-4668 Energy utilization; World Energy Engineering
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2899  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CB-163535] p0649 R80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LEL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSIOB  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space p0599 A80-4668  Energy utilization: World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31,
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Bankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 R80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems  p0765 A80-4830  Electrical power system for the SBS communication satellite  p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space  p0599 A80-4668  Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSIOB  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space p0617 A80-4830  Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LEL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSIOB  Design and performance of the International Sun-Earth Explorer power systems  p0765 A80-4830  Electrical power system for the SBS communication satellite p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space p0599 A80-4668  Energy utilization: World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers  p0570 A80-4758  Estimating solar irradiation sums from sunshine
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2899  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CB-163535] p0649 R80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space p0599 A80-4668  Energy utilization: World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers  p0570 A80-4758  Estimating solar irradiation sums from sunshine and cloudiness observations
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-VOL-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2989  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CR-163535] p0649 N80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite  p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space p0599 A80-4668  Energy utilization; World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers p0570 A80-4758  Estimating solar irradiation sums from sunshine and cloudiness observations
Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATE-80 (7773-03)-1-V0L-2]	cycle cooling of buildings  p0625 A80-5168  Solar powered absorption air conditioning p0629 A80-5347  Solar atrium: A hybrid solar heating and cooling system [DOE/CS-34135/6] p0633 N80-2892  Solar atrium: A hybrid solar heating and cooling system [ALO-4135-T2] p0639 N80-2899  Overview-absorption/Rankine solar cooling program [LBL-10770] p0640 N80-2990  Solar thermal heating and cooling. A bibliography with abstracts [NASA-CB-163535] p0649 R80-3196  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-3291  SOLAR ELECTRIC PROPULSION  Design and performance of the International Sun-Earth Explorer power systems p0765 A80-4830  Electrical power system for the SBS communication satellite p0617 A80-4830  SOLAR EMERGY Prospects for using solar energy to power materials-science furnaces in space p0599 A80-4668  Energy utilization: World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers  p0570 A80-4758  Estimating solar irradiation sums from sunshine and cloudiness observations

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Solar energy for buildings handbook		Solar hot water demonstration project at Red Star
[ORO-5362-T1]	p0631 N80-28880	Industrial Laundry, Fresno, California
Energy savings obtainable through pa	assive solar	[NASA-CR-161537] p0650 N80-32851
techniques		Use of solar energy to produce process heat for
[LA-UR-80-746]	p0632 N80-28891	industry
Organic photochemical storage of sol	lar energy	[SERI/TP-731-626] p0651 N80-32863
[COO-4380-3]	p0632 N80-28905	Combined cycle solar central receiver hybrid power
Sun Valley photovoltaic power project		system study. Volume 1: Executive summary
[ALO-4281-1]	p0633 N80-28909	[DOE/ET-21050/1-1] p0586 N80-32867
Simplified energy design economics:		Combined cycle solar central receiver hybrid power
economics applied to energy conser		system study, volume 2
solar energy investments in buildi		[DOB/ET-21050/1-2] p0586 N80-32868
[PB80-179245]	p0634 N80-29534	Residential photovoltaic flywheel storage system
Reporting format for thermal perform		performance and cost
heating and cooling systems in bui [PB80-175375]	p0634 N80-29537	[DOE/ET-20279/92] p0587 N80-32874
Solar heating and domestic hot water		Planning for electric utility solar applications:
installed at North Dallas High Sch		The effects on reliability and production cost estimates of the variability in demand
[NASA-CR-161482]	P0634 N80-29847	[SERI/TP-351-545] r0587 N80-32888
Solar space heating for the Visitors		Combined cycle solar central receiver hybrid power
Stephens College, Columbia, Missou		system study. Volume 3: Appendices
[NASA-CR-161485]	p0635 N80-29849	[DOE/ET-21050/1-3-VOL-3] p0587 N80-32893
Solar energy system performance eval	Luation.	Research and development for inertial energy
Seasonal report for Colt Pueblo, I	Pueblo, Colorado	storage based on a flexible flywheel
	p0635 N80-29850	[SAND-79-7097] p0778 N80-32898
Investigation of methods to predict		Seasonal thermal energy storage
stratification and its effect on a	solar energy	[PNL-3322] p0778 #80-32899
system performance		Solar index generation and delivery
[AD-A086051]	p0636 N80-29864	[DOE/ET-20090/3] p0654 N80-32929
The 20 percent solar energy goal: 1	rs ruere a bran	Gallium arsenide photovoltaic dense array for
to attain it? [EMD-80-64]	20630 NOU-20000	concentrator applications
[EMD-80-64] Solar energy system economic evaluat	•	[SAND-79-2270C] p0655 N80-32938
report for SEMCO-Loxabatchee; Loxa		Feasibility study on a solar house heating system with a low quality thermal flow
National Wildlife refuge, Palm Bea		[EUR-6696-EN] p0655 N80-32939
Florida	,	Line-focus solar central power system, phase 1.
[NASA-CR-161512]	p0641 N80-30894	Subsystem experiment: Receiver heat transfer
Solar heating and domestic hot water	r system	[DOE/ET-20550/1] p0655 N80-32945
installed at Kansas City, Fire Sta	ations, Kansas	Performance of storage walls with highly
City, Missouri		conductive covering plates and connecting films
	p0641 N80-30895	[SERI/TP-721-574] p0779 N80-32948
Solar energy system performance eval		Computer modeling of thermal storage walls
for IBM System 3, Glendo, Wyoming		[SERI/TP-721-610] p0779 N80-32949
[NASA-CR-161520]	p0641 N80-30896	Department of Housing and Orban Development solar
Comparative analysis of net energy h		hot water initiative: Centralized coordination
Satellite Power Systems (SPS) and	other energy	of technical tasks and system evaluation
systems [DOE/ER-0056]	p0582 N80-30916	[PB80-189244] p0656 N80-32961
Supplementary material on passive so		Solar passive systems for buildings [PB80-187719] p0656 N80-32962
concepts: A compilation of publis		[PB80-187719] p0656 N80-32962 Oversight: Wind energy program
· Presented in conjunction with a se		[GPO-51-382] p0591 N80-33872
passive solar heating seminars spo		Comprehensive planning for passive solar
Solar Energy Technology Transfer p		architectural retrofit
[PNL-SA-7820]	p0642 N80-30920	[AD-A088660] p0659 N80-33907
Development of solar driven absorpti	on air	Conservation and solar energy programs of the
conditioners and heat pumps	•	Department of Energy: A critique
[LBL-10771]	p0642 N80-30925	[PB80-197759] p0591 N80-33922
Energy analysis program, FY 1979		The use of solar energy for cooking
	p0582 N80-30942	p0659 N80-33953
Hydrogen production by the GA sulfur		SOLAR ENERGY ABSORBERS
	p0666 N80-31651	Structures, reduction potentials and absorption
Solar energy system economic evaluat Elcam-Tempe, Tempe, Arizona and El		maxima of synthetic dyes of interest in
San Diego, California	.cam-san prego,	photochemical solar-energy storage studies
[NASA-CR-161492]	p0644 N80-31872	p0595 A80-45314 The layer perovskites as thermal energy storage
Solar energy system demonstration pr		systems
Wilmington Swim School, New Castle		p0761 A80-45315
	p0644 880-31878	Evaluation of wall temperature difference profiles
Solar energy system performance eval	uation.	for heat absorption tubes exposed nonuniformly
Seasonal report for Wormser, Colum	ibia, South	to solar radiation
Carolina		p0596 A80-45319
[NASA-CR-161546]	p0644 N80-31880	Spectral effects on direct-insolation absorptance
Basic research needs and priorities		of five collector coatings
energy. Volume 1: Executive summ	ary.	[ASME PAPER 79-HT-18] p0597 A80-45722
Technology crosscuts for DOE	-064E NOO 34600	Reduction of intensity variations on the absorbers
[SERI/TR-351-358-VOL-1]	p0645 N80-31898	of ideal flux concentrators
Basic research needs and priorities		p0598 A80-46452
energy. Volume 2: Technology cro [SERI/TR-351-358-VOL-2]	p0645 N80-31899	Advanced thin silicon solar cell with controlled to
Investigation of learning and experi		optical absorptance for space power systems and arrays
[SERI/TR-353-459]	p0646 N80-31911	and arrays p0601 A80-46710
Residential solar heating and coolin		An S.E.M. study of thin films made by spray
evacuated tube solar collectors:		pyrolysis CdS deposition on solar
House 3, executive summary		
		photovoltaic panels
[COO-2858-24]	p0647 N80-31941	photovoltaic panels p0603 A80-46729

Solar selective black cobalt - Prepara structure, and thermal stability		Research issues for low cost photovoltaic cells p0605 A80-46748
Efficiency of quantum-utilizing solar converters in the presence of recomb		Numerical modelling of a solar cell in three dimensions p0605 A80-46749
P Experimental investigation of thermal characteristics of solar thermoeleme	0610 A80-46953	Bigh efficiency silicon solar cell for concentrator systems p0606 A80-46767
Calculation of heat-transport-medium f	0611 A80-47157 low rate in	AlSb as a candidate material for photovoltaic solar energy conversion
heat receivers of passive solar-heat p Investigation of the characteristics o	0611 A80-47159	p0608 A80-46787  Determination of the spectral distribution of global radiation with a rapid spectral
electrochemical coatings for solar-r collectors	adiation	radiometer and its correlation with solar cell efficiency
Theoretical study of absorbed solar en multi-layer absorber coatings for re	ceivers of	p0608 A80-46789 Operational characteristics of a 60 kW photovoltaic system integrated with a utility grid
solar concentrators. II - Heat trans [ASME PAPER 80-HT-105] p An emissometer with high accuracy for	fer analysis 0612 A80-48034	p0609 A80-46797 Efficiency of quantum-utilizing solar energy converters in the presence of recombination losses
determination of the total hemispher emittance of surfaces of solar e absorbers		p0610 A80-46953 Design of a thermophotocell p0610 A80-47154
Pew reflector design which avoids loss		Peat and wood as fuels - Another form of solar energy utilization
	0625 A80-51678	p0671 A80-47595  Beat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube
Solar powered absorption air condition p Analysis of the Omnium G receiver	ing 0629 A80-53475	p0762 A80-47598 A new method of efficient heat transfer and storage at very high temperatures
[SERI/TE-631-387] p Development of high temperature resist absorber surfaces	0637 N80-29872 ant, solar	p0762 A80-48180 Chemical Energy Storage for Solar Thermal Electric Conversion
[BMFT-FB-T-79-70] p Metallurgical analysis and high temper degradation of the black chrome sele		p0763 A80-48195 heat energy storage
	0643 N80-31538	p0765 A80-48241 Solar coal gasification p0616 A80-48243
[DOB/CS-30242/2] p Collector sealants and breathing	0649 180-31955	Analysis of small, nonconventional electric power systems for remote site applications
Design and fabrication of combined photovoltaic-thermal collectors	0650 N80-32527	p0765 A80-48272 Bydrogen production from the solar based LASL cadmium cycle
Oxidation of electrodeposited black ch selective solar absorber films		p0662 A80-48416 The JPL parabolic dish project solar collectors technology development
[SAND-80-1045C]  DLAE ENERGY CONVERSION  The sun-mill - A version of dunking-bi	00656 M80-32953 .rd as an	p0618 A80-48417 Photo-intercalation - Possible application in solar energy devices
energy convertor of sun's radiation  Closed-cycle helium gas turbine for so	0596 A80-45459 lar tower	p0620 180-48548 Heating requirements and estimations of solar energy available in Iran
power plant	0597 A80-46228	p0620 A80-48792 Solar energy utilization in a collective habitat - The Fribourg Solar Bouse in Brisgau
photoelectrochemical cells with low substrates		p0620 A80-48795 A theoretical study of the modelling and control
A solar thermophotovoltaic converter	0597 A80-46253 0597 A80-46256	of a solar water electrolysis plant p0621 A80-48919 A stochastic model for predicting solar system
Man-made molecular assemblies for ener conversion from light into chemical p		performance for water heating p0621 A80-48921 Photoreduction of carbon dioxide and water into
The benefits of solar power satellites p Reduction of intensity variations on t	0598 A80-46387	formaldehyde and methanol on semiconductor materials p0621 A80-48923
of ideal flux concentrators	0598 A80-46452	High temperature solar energy conversion systems . p0621 A80-48924 Concentrators and solar photovoltaics
conversion of sclar energy.	0599 180-46568	p0622 A80-50626 Solaser power solar energy lasing in space
	ceedings 0600 180-46694	p0622 A80-50627 Solar and wind energy - Its contribution to meeting future power requirements
The design of photovoltaic systems for applications in the United States	residential 0602 180-46716	p0623 A80-50816 Community Annual Storage Energy System p0773 A80-50910
Photoelectrochemical solar cells	0603 A80-46730	The solar power satellite concept - The past decade and the next decade p0623 A80-50951
p Requirements for future Air Force sate	0603 A80-46731 Ellite solar	Second law and radiation p0738 A80-51203
Batteries for solar electricity	06C4 A80-46736	End-use matching of solar energy systems p0624 A80-51208 Solar energy utilization by carbanion photolysis
P	0605 A80-46747	p0625 A80-51680

SUBJECT INDEX SOLAR PLUX DENSITY

Optimum working fluids for solar powered Bankine	Human comfort and auxiliary control considerations
cycle cooling of buildings	in passive solar structures
p0625 A80-51681 Visible light response of polycrystalline TiO2	[LBL-10034] p0640 N80-29903 Simultaneous photoproduction of hydrogen and
electrodes for solar energy conversion	oxygen by photosynthesis to convert solar
p0664 A80-51691	energy into stored chemical free energy
Energy choices and environmental constraints p0576 A80-51933	[CONF-791072-32] p0665 N80-30550 Solar energy system economic evaluation final
Alternative configurations for sodium-cooled solar	report for SEMCO-Loxahatchee, Loxahatchee
thermal power plants	National Wildlife refuge, Palm Beach County,
p0625 A80-52075 SOLABES orbiting mirror system	Plorida [NASA-CR-161512] p0641 N80-30894
[AAS 79-304] p0626 A80-52280	Solar energy system performance evaluation report
Predicting passive solar performance using modal	for IBM System 3, Glendo, Wyoming
expansions p0627 A80-52836	[NASA-CR-161520] p0641 N80-30896 Utility views on solar thermal central receivers
A semi-empirical method for estimating the	[SAND-80-8203] p0642 N80-30911
performance of direct gain passive solar heated	Solar assisted heat pump program overview and
buildings p0627 180-52838	summary of work at Brookhaven National Laboratory [BNL-27662] p0642 N80-30926
Simple design calculation procedure for passive	System design, tests results, and economic
solar houses p0627 180-52839	analysis of a flywheel energy storage and
Photovoltaic solar energy conversion; Proceedings	conversion system for photovoltaic applications [COO-4094-70] p0746 N80-30928
of the Conference, London, England, September	Three computer codes to read, plot and tabulate
28, 1979 p0628 A80-52860	operational test-site recorded solar data
Silicon solar cell array technology and the	[HASA-TH-78293] p0644 H80-31879 A quantitative evaluation of closed-cycle ocean
prospects for cost reduction	thermal energy conversion (OTEC) technology in
p0628 A80-52861 Amorphous silicon solar cells	central station applications [R-2595-DOE] p0749 N80-31885
p0628 A80-52863	[R-2595-DOE] p0749 N80-31885 A review of the methods for passive solar systems
Solar Power Generation Conference, San Jose,	analysis
Calif., August 8, 9, 1979, Proceedings p0629 A80-52867	[AD-A087509] p0645 #80-31895 Thermal energy storage for solar thermal
DOE solar thermal power systems program	applications program
p0629 A80-52869	[SAND-80-8218] p0646 N80-31918
DOE view of solar power commercialization and applications	Solar project description for Sir Galahad Company, single family residence, Virginia Beach, Virginia
p0629 A80-52870	[SOLAB/1028-79/50] p0646 B80-31920
A study on utilizing solar energy for hydrogen	Analytical modeling of line focus solar collectors
production p0665 A80-53569	[SERI/TP-333-591] p0647 N80-31926 Solar energy conversion through biophotolysis
Pluid selection for a 100 MW/e/ line focus solar	[SAN-0034-239-1-T2] p0666 N80-31927
central power station	Analytical evaluation of a solar
p0630 A80-53572 Integrated solar receiver/biomass gasifier research	thermophotovoltaic converter [SAND-78-1962] p0649 N80-31954
[SERI/TF-333-507] p0630 N80-28565	Hydrogen production by photoelectrolytic
Solar/hydrogen systems assessment. Volume 1:	decomposition of H2O using solar energy
Solar/hydrogen systems for the 1985 - 2000 time frame	[NASA-CR-163586] p0667 N80-32854 Satellite Power Systems (SPS) concept definition
[NASA-CR-163392] p0665 N80-28865	study. Volume 6: In-depth element investigation
Thermelectric materials for solar energy conversion	[NASA-CR-3323] p0651 N80-32859
[AD-A084948] p0631 NEO-28869 Multiple-tank high temperature storage subsystem	Line-focus solar thermal energy technology development. Report for Department 4720
[SAND-79-2056] p0775 N80-28878	[SAND-80-0865-REV] p0651 N80-32887
Electric utility solar energy activities: 1979survey	Chemical energy storage for solar thermal conversion [SAND-79-8198] p0652 N80-32889
[EPRI-ER-1299-SB] p0631 N80-28879	[SAND-79-8198] p0652 N80-32889 Fundamentals and techniques of nonimaging optics
Active solar energy system design practice manual	for solar energy concentration
[SOLAR/0802-79/01] p0632 N80-28889 Manual and programmable calculator methods for	[DOB/ER-04657/2] p0652 N80-32896 Potential for supplying solar thermal energy to
sizing solar energy systems ,	industrial unit operations
[EPRI-ER-1282-SR] p0632 N80-28890	[SERI/TP-632-584] p0588 N80-32911
Roof overhang design for solar control [CONF-791022-15] p0632 N80-28900	Electrochemical photovoltaic cells cdSe thin film electrodes
Cost-effective ways to improve the fabrication and	[DSE-4042-T16] p0654 N80-32925
installation of solar heating and cooling	Research on Cu sub x S/(cd, Zn)S photovoltaic
systems for residences [COO-4520-1] p0632 N80-28902	solar energy converters [LBL-10791] p0654 N80-32927
Concentrating solar collector test results	Concentrating photovoltaics for the tropics
[SAND-80-0801C] p0633 N80-28912 Internally insulated thermal storage system	[DOE/CS-04270/1] p0656 H80-32954 Potential displacement of petroleum imports by
development program	solar energy technologies
[SAND-80-8175] p0775 N80-28924	[SERI/TR-352-504] p0656 N80-32959
Electrochemical energy storage systems for solar thermal applications	Porecasts of energy technology. Citations from the International Aerospace Abstracts data base
[NASA-CE-163432] p0636 N80-29858	[NASA-CR-163596] p0782 N80-32965
Urban solar photovoltaics potential: An inventory	SOLAR PLUI
and modelling study applied to the San Fernando Valley region of Los Angeles	Maximum solar flux concentration achievable with axicon collectors
[NASA-CR-163436] P0636 N80-29859	p0625 A80-51679
Ground coupled solar heat rump research program in the United States	SOLAR FLOX DENSITY  Reduction of intensity variations on the absorbers
[BNL-27383] p0636 N80-29867	Reduction of intensity variations on the absorbers of ideal flux concentrators
Development of polyimide materials for use in	p0598 A80-46452
solar energy systems [DOE/CS-35305/T2] p0636 N80-29870	•
Farming and and and	

SOLAR FURBACES	
	The power system of the Aryabhata satellite
Prospects for using solar energy to power	p0743 N80-29387
materials-science furnaces in space	Design of a photovoltaic system for a southwest
p0599 A80-46688	all-electric residence
A study of the heat-induced fracture	[SAND-79-7056] p0637 N80-29876
characteristics of materials under intense	Advanced photovoltaic concentrator cells
radiant beating	[DSE-4042-T30] ·p0643 N80-30946
p0609 A80-46815	Solar passive systems for buildings
Note on the condensation of the vapor phase above	[NP-24377] p0643 N80-30947
a melt of iron oxide in a solar parabolic	Gasification of coal with solar energy
concentrator	[UCRL-84458] p0643 N80-31652
p0611 A80-47664	Small solar electric system components demonstration
Solar coal gasification	thermal storage modules for Brayton systems
p0616 A80-48243	[BASA-CR-163513] p0644 N80-31875
Study on the utilization of solar energy for the	Solar Central Receiver Hybrid Power Systems
operation of Spacelab material science furnaces	sodium-cooled receiver concept. Volume 2, book
[ESA-CR(P)-1301] p0640 N80-30348	1: Conceptual design, sections 1 through 4
Study on the utilization of solar energy for the	[DOE/ET-20567/1-2-BK-1] . p0645 N80-31896
operation of Spacelab material science furnaces	Solar Central Receiver Hybrid Power Systems
[DS-ERT-21-79] p0640 N80-30349	sodium-cooled receiver concept. Volume 2, book
Solar gasification of charcoal, wood and paper	<ol><li>Conceptual design, sections 5 and 6</li></ol>
[UCBL-84411] p3654 #80-32926	[DOE/ET-20567/1-2-BK-2] p0645 N80-31897
SOLAR GREERATORS	Design, construction, and operation of a 150 kW
Autonomous solar-electric systems	solar-powered irrigation facility, phase 2
p0596 A80-45477	[ALO-4159-1] p0645 180-31903
Closed-cycle helium gas turbine for solar tower	Evaluation of line focus solar central power
power plant	systems. Volume 1: Executive summary
[ONERA, TP NO. 1980-28] p0597 A80-46228	[ATR-80(7773-03)-1-VOL-1] p0648 N80-31943
Progress in the field of terrestrial solar	Solar central receiver hybrid power systems
generators ·	sodium-cooled receiver concept. Volume 1:
p0602 180-46713	Executive summary
A revised economic analysis of photovoltaic power	[DOE/ET-20567/1-1] p0648 N80-31948
modules	Residential photovoltaic systems: A review and
p0602.480-46715	comparative evaluation of four independent
Photovoltaic power generators in space	studies of potential concepts
p0604 180-46735	[SAND-80-7010] p0648 N80-31949
Photovoltaic generators using optical concentration	Solar powered rankine cycle irrigation pump
p0604 180-46739	[DOE/ET-20419/1] p0652 N80-32892
Integration of photovoltaic generation into a	Investigation of low-cost solar cells based on Cu20
large generating system	[DOE/ET-23006/3] p0653 N80-32915
p0604 A80-46743	US National Photovoltaics Program and applications
Analysis, design and realization of a 5 kW	experiments in the intermediate sector
photovoltaic generator	[SAND-80-0587C] p0654 N80-32935
p0605 A80-46745	Line-focus solar central power system, phase 1.
Study of a hydro-photovoltaic plant for peak power	Subsystem experiment: Receiver heat transfer
generation in central and northern European	[DOB/ET-20550/1] p0655 H80-32945
countries TOPONE NOT THE TOPONE NOT THE	SOLAR HEATING
p0605 A80-46746 Integrated Cu2S-CdS thin film solar cell generator	Investigation of nitrate salts for solar latent
p0606 A80-46770	heat storage p0595 180-45316
Engineering studies on the optimization of the	Heat loss and storage functions for a thermal well
collection subsystem of A I MW photovoltaic	p0596 A80-45318
facility	Performance of an inlet manifold for a stratified
p0609 A80-46794	storage tank
Metallic thermoelectric materials in solar	
thermoelectric generators	[ASME PAPER 79-HT-67] p0597 A80-45728 Calculation of heat-transport-medium flow rate in
thermoelectric generators	Calculation of heat-transport-medium flow rate in
p0610 A80-47152	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems
p0610 A80-47152 Estimating capacity of solar thermoelectric	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159
p0610 A80-47152 Estimating capacity of solar thermoelectric generator /STEG/ panels	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159 Investigation of temperature regime of
p0610 A80-47152 Estimating capacity of solar thermoelectric	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159
p0610 A80-47152 Estimating capacity of solar thermoelectric generator /STEG/ panels p0610 A80-47155	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159 Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162
p0610 A80-47152 Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155 Solar-powered Rankine engine assists air conditioning systems with electrical generating	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage
p0610 A80-47152 Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155 Solar-powered Bankine engine assists air	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube
p0610 A80-47152 Estimating capacity of solar thermoelectric generator /STEG/ panels p0610 A80-47155 Solar-powered Bankine engine assists air conditioning systems with electrical generating capability	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage
p0610 A80-47152 Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155 Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596 Comparison of advanced engines for parabolic dish solar thermal rower plants	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598
Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Rankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive
p0610 A80-47152 Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155 Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596 Comparison of advanced engines for parabolic dish solar thermal rower plants	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems  [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate
p0610 A80-47152 Estimating capacity of solar thermoelectric generator /STEG/ panels p0610 A80-47155 Solar-powered Rankine engine assists air conditioning systems with electrical generating capability p0611 A80-47596 Comparison of advanced engines for parabolic dish solar thermal power plants p0618 A80-48418	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage —— phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HY-17] p0611 A80-48008
p0610 A80-47152  Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage —— phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008 air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038
p0610 A80-47152 Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155 Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596 Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418 Thermal buffering of receivers for parabolic dish solar thermal power plants	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-H7-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors
p0610 A80-47152  Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage —— phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008 air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038
p0610 A80-47152  Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196
p0610 A80-47152  Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Rankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale
p0610 A80-47152  Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage rephase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198
p0610 A80-47152  Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Rankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston Stirling engine	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage —— phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008 A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038 Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198 Solar/electric district heating via CASES ——
p0610 A80-47152  Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Rankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston Stirling engine  p0619 A80-48467	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES Community Annual Storage Energy Systems
p0610 A80-47152  Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston  Stirling engine  p0619 A80-48467  Solar thermal electric power systems in Japan	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating systems p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems  [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors  [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES Community Annual Storage Energy Systems p0616 A80-48286
p0610 A80-47152  Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston  Stirling engine  p0619 A80-48467  Solar thermal electric power systems in Japan p0620 A80-48516	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage —— phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES —— Community Annual Storage Energy Systems p0616 A80-48286  Sensitivity analysis of the value of a solar
Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Rankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston Stirling engine  p0619 A80-48467  Solar thermal electric power systems in Japan p0620 A80-48516  Solar Power Generation Conference, San Jose,	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES Community Annual Storage Energy Systems p0616 A80-48286  Sensitivity analysis of the value of a solar driven chemical heat pump system
Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston Stirling engine  p0619 A80-48467  Solar thermal electric power systems in Japan p0620 A80-48516  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage —— phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems  [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors  [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES —— Community Annual Storage Energy Systems p0616 A80-48286  Sensitivity analysis of the value of a solar driven chemical heat pump system p0616 A80-48287
Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston Stirling engine  p0619 A80-48467  Solar thermal electric power systems in Japan p0620 A80-48916  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES Community Annual Storage Energy Systems p0616 A80-48286  Sensitivity analysis of the value of a solar driven chemical heat pump system p0616 A80-48287  Engineering prototype studies on the CaC12-C830B
Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Rankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston Stirling engine  p0619 A80-48467  Solar thermal electric power systems in Japan p0620 A80-48516  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  Performance characteristics of a commercially	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES Community Annual Storage Energy Systems p0616 A80-48286  Sensitivity analysis of the value of a solar driven chemical heat pump system p0616 A80-48287  Engineering prototype studies on the CaCL2-CR30B chemical heat pump for solar air conditioning,
Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston Stirling engine  p0619 A80-48467  Solar thermal electric power systems in Japan p0620 A80-48516  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings  p0629 A80-52867  Performance characteristics of a commercially available, point-focus, solar power system	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage —— phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008 air-heating solar collectors [ASME PAPER 80-HT-17] p0612 A80-48038 air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038 air/tock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES —— Community Annual Storage Energy Systems p0616 A80-48286  Sensitivity analysis of the value of a solar driven chemical heat pump system p0616 A80-48287  Engineering prototype studies on the CaCI2-CB30E chemical heat pump for solar air conditioning, heating, and storage
Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Rankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston Stirling engine  p0619 A80-48467  Solar thermal electric power systems in Japan p0620 A80-48516  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings p0629 A80-52867  Performance characteristics of a commercially available, point-focus, solar power system p0629 A80-53570	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008  A two-dimensional analysis of flat plate air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038  Air/rock storage for solar central receiver power stations p0613 A80-48198  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES Community Annual Storage Energy Systems p0616 A80-48286  Sensitivity analysis of the value of a solar driven chemical heat pump system p0616 A80-48287  Engineering prototype studies on the CaCl2-CB30B chemical heat pump for solar air conditioning, heating, and storage
Estimating capacity of solar thermoelectric generator /STEG/ panels  p0610 A80-47155  Solar-powered Bankine engine assists air conditioning systems with electrical generating capability  p0611 A80-47596  Comparison of advanced engines for parabolic dish solar thermal power plants  p0618 A80-48418  Thermal buffering of receivers for parabolic dish solar thermal power plants  p0618 A80-48419  Power processing and control requirements of dispersed solar thermal electric generation systems  p0619 A80-48465  An advanced 15 kW solar powered free-piston Stirling engine  p0619 A80-48467  Solar thermal electric power systems in Japan p0620 A80-48516  Solar Power Generation Conference, San Jose, Calif., August 8, 9, 1979, Proceedings  p0629 A80-52867  Performance characteristics of a commercially available, point-focus, solar power system	Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159  Investigation of temperature regime of single-story house with solar heating system p611 A80-47162  Heat storage utilizing Thermol 81 Energy Storage —— phase change material in polyethylene tube p0762 A80-47598  Simulation and a preliminary comparison of passive solar heating systems [ASME PAPER 80-HT-17] p0611 A80-48008 air-heating solar collectors [ASME PAPER 80-HT-17] p0612 A80-48038 air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-48038 air/tock storage for solar central receiver power stations p0613 A80-48196  Solar retorting of oil shale p0613 A80-48198  Solar/electric district heating via CASES —— Community Annual Storage Energy Systems p0616 A80-48286  Sensitivity analysis of the value of a solar driven chemical heat pump system p0616 A80-48287  Engineering prototype studies on the CaCI2-CB30E chemical heat pump for solar air conditioning, heating, and storage

p0630 A80-53572

p0618 480-48367

SUBJECT INDEX SOLAR HEATING CONTD

Ceramic dome receiver technology developments Solar energy system performance evaluation. p0619 A80-48466 Seasonal report for SEECO Lincoln, Lincoln, Test evaluation of a prototype 18-ton solar powered heating and cooling system Nebraska [ NASA-CR- 161495] p0635 N80-29851 p0619 A80-48480 Solar energy system performance evaluation: Heating requirements and estimations of solar Seasonal report for Contemporary Newman, Newman, energy available in Iran Georgia . p0620 A80-48792 [ NASA-CE-161494] p0635 N80-29853 Solar energy system economic evaluation: IBM System 2, Togus, Maine
[NASA-CR-161510] p0635 N8 The optimal interconnection of solar collectors in air heating systems with large collector surfaces p0620 A80-48794 p0635 N80-29854 Similarity theory of solar water heater with natural circulation Solar energy system performance evaluation: Seasonal report for Pern Lansing, Lansing, p0621 A80-48517 A stochastic model for predicting solar system Michigan [NASA-CR-161491] performance --- for water heating Solar energy system performance evaluation p0621 A80-48921 Seasonal report for IBM System 1B, Carlsbad, New A design method for parallel solar-heat pump systems p0621 A80-48922 Bexico [NASA-CR-161508] -p0635 N80-29856 A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs Engineering design for Thermocrete central storage units for low temperature solar application [DOB/CS-34702/4] p0638 N80-29883 Passive solar heating and natural cooling of an p0624 A80-50968 Thermal energy storage using saturated salt earth-integrated design [CONF-800449-1] solutions p0774 A80-51125 A thermal performance evaluation technique for passive space heating systems [CONF-800449-1] p0638 N80-29884 Electric utilities and residential solar systems [BNL-27711] p0638 N80-29888 p0626 A80-52827 Solar atrium: A hybrid solar heating and cooling Trombe wall ws direct gain - A comparative analysis of passive solar heating systems system [ ALO-4135-T2] p0639 N80-29899 [NASA-CR-161509] p0039 800-296

[NASA-CR-161509] p0641 N80-308

Performance estimates for attached sunspace p0626 A80-52828 The effect of design parameter changes on the performance of thermal storage wall passive p0641 N80-30893 systems p0626 A80-52829 passive solar heated buildings. Determining the optimum design of the solar modulator --- solar house reflective louver [LA-UR-80-853] p0642 N80-30913 Solar passive systems for buildings [NP-24377] p0626 A80-52830 p0643 N80-30947 [NP-24377] p0643 N80-30
Regenerative energy sources for the production of
low temperature heat: Energy sources, energy
types, and energy conversion; results and
applications; measures to promote use
[ISBN-3-7041-0038-2] p0702 N80-30
Solar domestic hot water system, a comparative
study and storage tank investigation Applications of DOE-1 to passive solar heating of commercial buildings - Preliminary results p0626 A80-52831 The economic feasibility of passive solar space p0702 N80-30951 heating systems p0627 A80-52832 Experimental investigation of the Trombe wall p0643 N80-31868 passive solar energy system p0627 A80-52833 A comparison of performance factors for passive Solar energy system demonstration project at Wilmington Swim School, New Castle, Delaware [NASA-CR-161538] p0644 N80-31878 Solar energy system performance evaluation. solar heating p0627 A80-52837 A semi-empirical method for estimating the performance of direct gain passive solar heated buildings Seasonal report for Wormser, Columbia, South Carolina p0627 A80-52838 Solar energy system performance evaluation: Simple design calculation procedure for passive Seasonal report for Colt Yosemite, Yosemite National Park, California [NASA-CR-161539] p0645 N8 solar houses p0645 N80-31883 p0627 A80-52839 Solar powered absorption air conditioning p0629 A80-52839

Installation guidelines for solar heating system, single-family residence at William OBrien State Park, Stillwater, Minnesota [NASA-CE-161480] p0630 N80-28861

Solar atrium: A hybrid solar heating and cooling Solar energy applications for dwelling; modelling and simulation part [ EUR-6681/I-EN ] review of the methods for passive solar systems analysis
[AD-A087509] p0645 N80-31895 Absorption refrigeration machine driven by solar [DOP/CS-34135/6] p0633 N80-Solaroil project. Phase 1: Preliminary design p0633 N80-28928 [EUR-6748-EN] p0646 N80-31914
Solar project description for Sir Galahad Company,
single family residence, Virginia Beach, Virginia
[SOLAE/1028-79/50] p0646 N80-31920 report [GA-A-15823] P0633 N80-29505 [NSA-CE-16183]

Solar heating of buildings and domestic hot water [AD-A085815]

Solar heating and hot water system installed at office building, One Solar Place, Dallas, Texas [NSA-CE-161483]

Solar heating and domestic hot water system Pederal demonstrations of solar heating and cooling on commercial buildings have not been very effective
[EMD-80-41] p0750 N80-31929
Evaluation of control strategies for solar collector loops installed at North Dallas High School
[NASA-CR-161482] p0 [LBL-10716] p0647 N80-31932 p0634 N80-29847 Solar assisted heat pump studies: Heat pump hardware and experiments, simulations, Earth coupling contracts and supporting contracts Solar heating and cooling system installed at Leavenworth, Kansas [NASA-CB-161484] [NASA-CE-161484] p0635 N80-29848 Solar space heating for the Visitors Center, Stephens College, Columbia, Missouri [NASA-CE-161485] [BNL-27668] p0647 N80-31933 Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar CSU Solar House 3, executive summary Solar energy system performance evaluation.
Seasonal report for Colt Pueblo, Pueblo, Colorado
[NASA-CR-161493] p0635 N80-29850 [COO-2858-24] p0647 N80-31941 Passive solar heating of buildings with attached

greenhouse [ DOE/CS-30242/2]

p0649 N80-31955

Solar thermal heating and cooling. A bibliography	Solar project description for Sir Galahad Company,
with abstracts [NASA-CR-163535] p0649 N80-31963	single family residence, Virginia Beach, Virginia [SOLAE/1028-79/50] p0646 #80-3192
Solar hot water demonstration project at Red Star	SOLAR PORDS (HEAT STORAGE)
Industrial Laundry, Fresno, California [NASA-CR-161537] p0650 N80-32851	Heat loss and storage functions for a thermal well p0596 A80-4531
Monitoring of the performance of a solar heated	Computer simulation of solar pond thermal behavior
and cooled apartment building	p0599 A80-4656
[DSE-5235-11] p0653 N80-32913 Solar index generation and delivery	Salton Sea solar pond project p0617 180-4836
[DOE/ET-20090/3] p0654 N80-32929	Management of a large, operational solar pond
Performance of storage walls with highly conductive covering plates and connecting films	p0617 A80-4836 Key questions in the application of
[SERI/TP-721-574] p0779 N80-32948	salt-stratified solar ponds
Solar passive systems for buildings [PB80-187719] p0656 N80-32962	p0617 A80-4836 Operational experience with a saturated borax
Optimum systems design with random input and	solar pond
output applied to solar water heating p0657 N80-33654	p0617 A80-48369 Laboratory demonstration of self-creation,
Solar heating system at Quitman County Bank,	self-maintenance and self-correction of
Marks, Mississippi [NASA-CR-161549] p0657 N80-33858	saturated solar ponds p0618 A80-4836
Installation, operation, and maintenance for the	Solar ponds for district heating and electricity
pyramidal optics solar system installed at Yacht Cover, Columbia, South Carolina	generation p0618 A80-4836
[NASA-CR-161203] p0657 N80-33864	Transient thermal behaviour of solar ponds
Design data brochure for a pyramidal optical solar system	p0623 A80-5096; Solar passive systems for buildings
[NASA-CR-161202] p0657 N80-33865	[NP-24377] p0643 H80-3094
Installation package for a sunspot cascade solar	Solar ponds and their applications [SERI/TP-733-617] p0655 N80-3294
water heating system [NASA-CR-161562] p0657 N80-33866	SOLAR POWER SATELLITES
Design package for solar domestic hot water system [NASA-CR-161558] p0657 N80-33867	The benefits of solar power satellites p0598 A80-4638
Comprehensive planning for passive solar	Solar power satellites - The ionospheric connection
architectural retrofit [AD-A088660] p0659 N80-33907	p0757 A80-4639 Requirements for future Air Force satellite solar
SOLAR HOUSES	power technology
Working fluids for solar, Rankine-cycle cooling systems	p0604 A80-46730 Environmental protection of the solar power
p0595 A80-45299	satellite
Investigation of temperature regime of single-story house with solar heating system	p0609 A80-4689 Solar power satellites - The present and the future
p0611 A80-47162	p0757 A80-4756
Heat storage utilizing Thermol 81 Energy Storage phase Change material in polyethylene tube	The SPS concept - An overview of status and outlook Satellite Power System
p0762 A80-47598	p0617 A80-4835.  Potential economics of large space based solar
Simulation and a preliminary comparison of passive solar heating systems	power stations
[ASME PAPER 80-HI-17] p0611 A80-48008	p0617 A80-4835 Solaser power solar energy lasing in space
Performance of storage walls with highly conductive covering plates and connecting fins	p0622 A80-5062
[ASHE PAPER 80-HT-18] p0762 A80-48009	Satellite power systems for Western Europe - Problems and solution proposals
DEBOB - A system for simulating the dynamic energy performance of rassive solar structures	p0622 A80-5063
[ASHE PAPER 80-HT-21] p0612 A80-48011 Residential photovoltaic systems	The solar power satellite concept - The past decade and the next decade
p0615 A80-48228	p0623 A80-5095
Solar energy utilization in a collective habitat - The Pribourg Solar House in Brisgau	Status of the satellite power system concept development and evaluation program
p0620 A80-48795	p0623 A80-5095
Energy conservation and solar houses p0623 A80-50941	Rockwell Satellite Power System /SPS/ concept definition studies
Performance monitoring of low energy house,	p0623 180-5095 The photoklystron for satellite solar energy
Macclesfield p0575 A80-50944	conversion
National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings	p0623 A80-5095. The first realistic solar energy project
p0626 A80-52826	p0758 A80-5099
Predicting passive solar performance using modal expansions	The power system of the Aryabhata satellite p0743 N80-2938
P0627 A80-52836	European technology applicable to Solar Power
Simple design calculation procedure for passive solar houses	Satellite Systems (SPS) [INKA-CONF-79-378-046] p0637 B80-2987
P0627 A80-52639	Preliminary comparative assessment of land use for
Cost and thermal performance comparisons for wall systems as applied to passive solar building	the Satellite Power System (SPS) and alternative electric energy technologies
p0628 A80-52842	[NASA-CR-163327] p0580 N80-2988
Environmental data for sites in the National Solar Data Network monitoring performance of solar	Electric propulsion for SPS p0643 N80-3146
energy demonstration projects	A computer model of solar panel-plasma interactions
[SOLAB/0010-79/12] p0633 N80-28947 User evaluation study of passive solar residences	[NASA-CR-160796] p0650 H80-3285 Satellite Power Systems (SPS) concept definition
[SERI/TE-63-350] p0638 N80-29882	study. Volume 6: In-depth element investigation
Electric utilities and residential solar systems [BHL-27711] p0638 N80-29888	[NASA-CR-3323] p0651 N80-3285 Satellite power system (SPS) concept definition
Solar energy system performance evaluation report	study. Volume 3: Experimental Verification
for IBM System 4 at Clinton, Mississippi [NASA-CR-161509] p0641 N80-30893	definition [NASA-CR-3320] p0651 N80-3286

SUBJECT INDEX SOLID WASTES

Satellite Power Systems (SPS) concept definition study. Volume 5: Special emphasis studies --rectenna and solar power satellite design studies
[NASA-CR-3322] p0651 N80-32861 Form factor for certain types of toroidal solenoids --- in tokamak fusion devices n0721 180-47230 Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p065 p0654 N80-32928 Transfer function of a sensible-heat storage element in periodic regime Total and non-isotropic diffuse insolation on nG774 A80-52974 tilted surfaces SOLID WASTES p0599 A80-46571 A synergistic solid waste to energy project -Phase 1 project concept Analytic representation of distribution laws for energy structure of solar-radiation regime p0570 A80-47586 Energy from MSW - The industrial market --Municipal Solid Waste p0611 A80-47161 Daily irradiations measured on three photovoltaic systems in Toulouse p0670 A80-47588 D0620 A80-48791 Municipal solid waste as an industrial fuel p0670 180-47589 Heating requirements and estimations of solar energy available in Iran Wood energy systems - An assessment p0670 A80-47593 Second law and radiation Energy from wood waste - A case study p0738 A80-51203 p0670 A80-47594 Gallium arsenide solar cells for very high Municipal solid waste and district heating - A ; concentration systems: Recent results, problems case study and expectations The role of refuse derived fuel /BFD/ as an alternative energy source for district heating and power generation p0649 N80-31962 [CISE-1518] Spectral character of solar and circumsolar radiation --- for application to concentrating solar energy systems [LBL-10802] SOLAR REFLECTORS p0675 A80-48331 p0653 N80-32916 Recycling World Congress, 2nd, Manila, Philippines, March 19-22, 1979, Proceedings Multi-hundred kW solar arrays for space p0678 A80-49537 p0617 A80-48355 The producing mechanism, separative and fuel p0617 A80-48
New reflector design which avoids losses through
gaps between tubular absorbers and reflectors characteristics of municipal refuse p0679 A80-49539 for solar collectors The efficiency of recovering energy and materials p0625 A80-51678 from solid waste p0574 A80-49933 SOLARES orbiting mirror system [AAS 79-304] p0626 A80-52280
Determining the optimum design of the solar
modulator --- solar house reflective louver Anatomy of regional solid waste resource recovery projects p0574 A80-49939 p0626 A80-52830 Potential for conversion of refuse to energy in Ontario Canada and the Provincial Energy from Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATR-80(7773-03)-1-Vol-2] p0644
SOLAR SIMULATION Waste program p0648 N80-31944 p0681 A80-49946 Energy recovery from solid waste for city of Tehran p0681 A80-49948 Environmental impact of conversion of refuse to Predicting passive solar performance using modal expansions p0627 A80-52836 p0574 180-49954
Co-combustion trials of pretreated solid urban
refuse, on a brown coal-fired boiler SOLAR SIMULATORS A low cost solar simulator for testing photovoltaic terrestrial solar power cells and modules The combustion engineering approach to municipal solid waste energy recovery D0604 A80-46738 SOLAR TERRESTRIAL INTERACTIONS An overview of NASA's participation in the p0681 A80-49959 nation's energy program . Combined production of electrical energy and heat in municipal refuse incinerators in the greater p0625 A80-51950 SOLAR TOTAL ENERGY SYSTEMS Paris area Sizing procedure and economic optimization methodology for seasonal storage solar systems p0682 A80-49965 The gasification of municipal and industrial waste in accordance with the SPW-FUNK-Process A80-46570 Hybrid system consisting of silicon solar cells with concentrators and heat pump p0682 A80-49979 Recent developments in a slagging process for conversion of refuse to energy P0608 A80-46792 Sandia battery program for energy storage in photovoltaic systems p0682 A80-49981 Integrated system for solid waste disposal with energy recovery and volumetric reduction by new p0767 A80-48368 Comparative economics of small solar thermal pyrolysis furnace electric power systems p0682 A80-49982 Biogas from residues of animal husbandry and Assessment of solar thermal concepts for small power systems applications agricultural plant production p0683 A80-49994 p0618 A80-48463 The production of substitute natural gas and An overview of NASA's participation in the recyclables from municipal solid waste p0683 A80-49996 nation's energy program p0625 A80-51950 Dynamic simulation and development of a control Biogasification of municipal waste p0683 A80-49997 strategy for a distributed, concentrating solar collector field Economic and technical evaluation of the Ames, Iowa solid waste recovery system p0629 A80-53571 Comparison of solar-thermal and fossil total-energy systems D0683 A80-50005 Energy recycling through refuse pelletizing p0683 A80-50008 total-energy systems for selected industrial. Combustible briquets from waste using the PINEDA/LOAS process applications [ORNL/TM-7022] p0586 N80-32871 Self controlling, self pumping heat circulation p0683' A80-50009 system study [COO-4484-07] Brini - A completion to solid fuels --- municipal p0656 N80-32952 solid wastes conversion

p0684 A80-50017

Plue gas recirculation as a means of solid waste incineration process	improving the	SPACE COMMUNICATION  Future space power - The D.O.D. perspect:	ive
,	p0688 A80-53057		22 A80-4817
SOLIDIFICATION Heat transfer - San Diego 1979; Proc		SPACE COOLING (BUILDINGS)  DEROB - A system for simulating the dynamics of the	
Eighteenth National Conference, Sa Calif., August 5-8, 1979	n Diego,	performance of passive solar structure: [ASME PAPER 80-HT-21] p06	s 12 A80–4801
	p0781 A80-53568	Seasonal thermal energy storage of chille	
SOLIDS A high volume process for silicon so	lar cells	in aquifers p070	66 A80-4833
using solid diffusion sources		Twenty years of experience with well-water	
SOLVEST BITRACTION	p0601 A80-46707	heat pumps at Battelle's Columbus Labor	ratories 33 A80-4848
Disposable catalysts in the solvent	refined coal	Community Annual Storage Energy System	73 A80-5091
processes	p0676 A80-48381	Second law analysis of energy devices and	
Approach to steady-state solvent com		processes; Proceedings of the Workshop	, George
the SRC-I coal liquefaction proces	s p0676 A80-48382	Washington University, Washington, D.C. 14-16, 1979	., August
Brxon Donor Solvent Coal Liquefactio		p05°	76 A80-5120
Development Program Status	p0677 A80-48430	Optimum working fluids for solar powered cycle cooling of buildings	Rankine
LC-Pining of solvent refined coal -		p06	25 480-5168
short contact time coal extracts -		A classification scheme for the common p	assive and
Cities Fining catalytic hydrogenat	ion process p0678 A80-48431	hybrid heating and cooling systems	27 A80-5283
Development and application of analy		Solar powered absorption air conditioning	
techniques to chemistry of donor s	olvent		29 A80-5347
liquefaction [PE-2696-T4]	p0695 N80-29472	Reporting format for thermal performance heating and cooling systems in building	
Development and application of analy			34 B80-2953
techniques to chemistry of donor s		Photovoltaic/thermal hybrid projects	
liquefaction	p0712 N80-33520		38 N80-2988
[DOB/PC-20041/T1] SOLVEST BEFINED COAL	p0/12 860-33320	Supplementary material on passive solar in concepts: A compilation of published a	
Research and development of an advan	ced process	Presented in conjunction with a series	
for the conversion of coal to synt	hetic gasoline	passive solar heating seminars sponsor	
and other distillate fuels [PE-2306-38]	p0696 880-29513	Solar Energy Technology Transfer progra [PNL-SA-7820] p06	am 42 N80-3092
Research and development of an advan		A review of the methods for passive solar	
for the conversion of coal to synt	hetic gasoline	analysis	
and other distillate fuels [PE-2306-35]	p0696 N80-29514	[AD-A087509] p064 Solar thermal heating and cooling. A bi	45 N80-3189 blicaraphy
Refining and upgrading of synfuels f		with abstracts	
oil shales by advanced catalytic p	rocesses.		49 N80-3196
Laboratory and pilot plant studies processing of SRC-1	or the	Heat pumps in low temperature application [COMP-800806-7] p07	ns 11 #80-3269
[PE-2315-45]	p0699 N80-30544	Thermal energy storage for building heat:	
Upgrading of coal liquids: Eydrocra	cking of EDS	cooling applications	77 800 2207
process defived gas oils [PE-2566-33]	pQ699 N80-30545	[ORNL/TM-7319] p07' Annual Cycle Energy System (ACES)	77 180-3287
Applied research and evaluation of p	rocess	[ORNL/CON-42] pos	87 N80-3288
concepts for liquefaction and gasi western coals	fication of	Seasonal thermal energy storage p07	78 N80-3289
[ PE-2006-17 ]	p0700 N80-30549	Theory and design of an Annual Cycle Ener	
Materials technology for coal-conver	sion processes	(ACES) for residences	
[ANL-80-12] SOLVENTS	p0700 N80-30551	[ORNL/CON-43] p05: Monitoring of the performance of a solar	87 N80-3290
Low cost solar cells based on amorph	ous silicon	and cooled apartment building	20000
electrodeposited from organic solv	ents p0648 N80-31953		53 N80-3291
[SAN-0113-040-T6]	pue46 #60-31333	SPACE ENVIRONMENT SINULATION  The Intelsat V nickel- cadmium battery s	vsten
Soot reduction in diesel engines by	catalytic	p070	69 A80-4839
effects [BNL-27792]	p0585 N80-32731	SPACE HEATING (BOILDINGS) Investigation of temperature regime of	
SORBERTS	P0303 ECO 3273.	single-story house with solar heating :	system
Methods of improving limestone utili	zation in		11 480-4716
fluidized-bed combustion	p0672 A80-48170	Performance of storage walls with highly conductive covering plates and connect:	
An engineering study on the use of r			62 A80-4800
calcium silicates sorbent for APB		DEROB - A system for simulating the dynamic	
generation from bigh sulfur coal - Pluidized Bed	atmospheric	performance of passive solar structure: [ASME PAPER 80-HT-21] p06	s 12 A80-4801
SORPTION	p0672 A80-48171	Municipal solid waste and district heating case study	
Recovery of ethanol from fermentatio	n broths using		27 A80-4828
selective sorption-desorption		Sensitivity analysis of the value of a se	
Alternative process schemes for coal	p0678 A80-48516	driven chemical heat pump system	16 A80-4828
[BNL-51117]	p0692 880-28560	Development status and utility of the su	lfuric
Sorption properties of sediments and		acid chemical heat pump/chemical energy	
energy-related pollutants	, PUEBO MBU-33603	system por	65 A80-4828
[PB80-189574] SOUTH APRICA	P0589 N80-32997	An energy and cost analysis of residentia	
The aerodynamics of contra-rotating	azial flow	pumps in northern climates	
wind power turbines [CSIR-ME-1638]	p0755 N80-33868	p05 Simulation and evaluation of latent heat	71 A80-4842 thermal
F			

SUBJECT INDEX SPACE POWER REACTORS

Twenty years of experience with well-water-source heat pumps at Battelle's Columbus Laboratories Solar energy applications for dwelling; modelling and simulation part The optimal interconnection of solar collectors in air heating systems with large collector surfaces [BUR-6681/I-EN] Pederal demonstrations of solar heating and cooling on commercial buildings have not been p0620 A80-48794 very effective [BMD-80-41] p0750 N80-31929 Community Annual Storage Energy System p0773 A80-50910 Solar assisted heat pump studies: Heat pump hardware and experiments, simulations, Earth coupling contracts and supporting contracts Energy conservation and solar houses p0623 A80-50941 Second law analysis of energy devices and processes; Proceedings of the Workshop, George Washington University, Washington, D.C., August [BNL-27668] p0647 N80-31933 Passive solar heating of buildings with attached greenhouse 14-16, 1979 [DOE/CS-30242/2] p0576 A80-51202 Solar thermal heating and cooling. A bibliography A thermal performance evaluation technique for with abstracts With abstracts
[NASA-CR-163535]
P0649
Heat pumps in low temperature applications passive space heating systems p0649 N80-31963 p0711 N80-32699 The effect of design parameter changes on the [CONF-800806-7] Thermal energy storage for building heating and cooling applications
[ORNL/TM-7319] p0777 N80performance of thermal storage wall passive p0626 A80-52829 D0777 N80-32879 Determining the optimum design of the solar modulator --- solar house reflective louver Annual Cycle Energy System (ACES)
[ORNL/CON-42]
Seasonal thermal energy storage p0587 N80-32880 p0626 A80-52830 [PNL-3322] p0778 N80-328 Theory and design of an Annual Cycle Energy System Applications of DOE-1 to passive solar heating of commercial buildings - Preliminary results p0778 N80-32899 p0626 A80-52831 (ACES) for residences
[OBNL/CON-43] The economic feasibility of passive solar space p0587 N80-32904 heating systems Economic evaluation of the Annual Cycle Energy System (ACES). Volume 1: Executive summary [ORML/SUB-7470/1-V1] p0587 N80-32905 Monitoring of the performance of a solar heated and cooled apartment building p0627 A80-52832 A classification scheme for the common passive and hybrid heating and cooling systems p0627 A80-52835 A comparison of performance factors for passive p0653 N80-32913 [DSE-5235-T1] Feasibility study on a solar house heating system with a low quality thermal flow A semi-empirical method for estimating the performance of direct gain passive solar heated [EUR-6696-EN] Performance of storage walls with highly conductive covering plates and connecting films [SERI/TP-721-574] p0779 880-32948 p0627 A80-52838 [SERI/TP-721-574] p0//9 movComputer modeling of thermal storage walls
[SERI/TP-721-610] p0779 M80Investigation of the feasibility of using wind
power for space heating in colder climates Cost and thermal performance comparisons for wall systems as applied to passive solar building p0779 N80-32949 p0628 A80-52842
Installation guidelines for solar heating system, single-family residence at William OBrien State [DOE/DP-03533/T3] p0753 N80-32950 Park, Stillwater, Minnesota
[NASA-CE-161480] p0630 N80-28861
Heat-pump-centered integrated community energy Development of an energy consumption and cost data base for fuel cell total energy systems and conventional building energy systems systems: System development summary [ANL/CNSV-7] [ORNL/CON-38] p0754 N80-32960 [ANL/CHSV-7] p0578 N80-28885 Cost-effective ways to improve the fabrication and installation of solar heating and cooling Solar passive systems for buildings
[PB80-187719] p0656 B
Solar heating system at Cuitman County Bank, p0656 N80-32962 systems for residences
[COO-4520-1] p0632 N80-28902
Environmental data for sites in the National Solar Marks, Mississippi [NASA-CR-161549] p0657 N80-33858 Installation, operation, and maintenance for the pyramidal optics solar system installed at Yacht Data Network --- monitoring performance of solar energy demonstration projects
[SOLAR/0010-79/12] p0633 N80-28947
Solar heating of buildings and domestic hot water
[AD-A085815] p0634 N80-29532 Cover, Columbia, South Carolina [NASA-CR-161203] p0657 N80-33864 Design data brochure for a pyramidal optical solar system Reporting format for thermal performance of solar [NASA-CR-161202] p0657 #80-33865 Comprehensive planning for passive solar architectural retrofit heating and cooling systems in buildings [PB80-175375] p0634 p0634 N80-29537 Photovoltaic/thermal hybrid projects [BNL-276691 [AD-A088660] p0659 N80-33907 p0638 N80-29881 [BBL-27669] p0638 NeO-29881
Assessment of integrated urban energy options
[pB80-173644] p0581 N8O-30234
Solar heating and domestic hot water system SPACE INDUSTRIALIZATION Scaling and the start-up phase of space industrialization p0598 A80-46386
The extraterrestrial imperative. III - New earth-space energy maintain. installed at Kansas City, Fire Stations, Kansas City, Missouri [NASA-CR-161513] D0688 A80-53323 Supplementary material on passive solar heating Supplementary material on passive solar heating concepts: A compilation of published articles. Presented in conjunction with a series of passive solar heating seminars sponsored by the Solar Energy Technology Transfer program [PNL-SA-7820] P0642 M80-30920 Solar energy system demonstration project at Wilmington Swim School, New Castle, Delaware [NASA-CR-161538] P0644 N80-31878 Solar energy system performance evaluation. Prospects for using solar energy to power materials-science furnaces in space p0599 A80-46688 SPACE MISSIONS Future space power - The D.O.D. perspective p0722 A80-48174 SPACE PLASMAS A computer model of solar panel-plasma interactions [NASA-CE-160796] p0650 N80-3285 Solar energy system performance evaluation.
Seasonal report for Wormser, Columbia, South p0650 N80-32853 SPACE PLATFORMS Carolina Technology for large space systems. A special [ NASA-CH-161546 ] bibliography with indexes, supplement 3 [NASA-SP-7046 (03)] p064 p0644 N80-31880 Solar energy system performance evaluation: Seasonal report for Colt Yosemite, Yosemite National Park, California p0649 N80-32410 SPACE POWER REACTORS Air Force space power technology program

p0645 N80-31883

[NASA-CR-161539]

p0782 N80-33468

•	
SPACE PROCESSIEG Scaling and the start-up phase of space industrialization	The 1980 technology status of the Dynamic Isotope Power System p0725 A80-48255
p0598 A80-46386 SPACE SHOTTLE ORBITEES	A six kilowatt transformer-coupled converter for Space Shuttle solar power systems
Large area flexible solar array design for Space Shuttle application	p0616 A80-48262 BTG power source for the International Solar Polar Bission
p0615 A80-48214 A six kilowatt transformer-coupled converter for Space Shuttle solar power systems	p0727 180-48305 Design and performance of the International
p0616 A80-48262 SPACE SHUTTLES	Sun-Earth Explorer power systems p0765 A80-48307
A study of a space communication system for the control and monitoring of the electric	Electrical power subsystem for IMSAT-I p06 16 A80-48308
distribution system. Volume 1: Summary [NASA-CR-163477] p0760 880-31268 SPACE STATIONS	Electrical power system for the SES communication satellite p0617 A80-48309
Study of power management technology for orbital multi-100KWe applications. Volume 3:	Mission analysis of the P78-2 pover subsystem after one year of operation
Requirements [NASA-CR-159834] p0759 H80-29845 SPACE SURVELLANCE	p0765 A80-48310 Power management for multi-100 KWe space systems p0758 A80-48357
Puture space power - The D.O.D. perspective p0722 A80-48174	RCA Satcom F1 and F2 Bi-Cd battery orbital performance
SPACE TRANSPORTATION SISTEM  NASA program plan [Nasa-tm-81136] p0781 880-31269	p0769 A80-48394 The Intelsat V nickel- cadmium battery system p0769 A80-48395
[NASA-TH-81136] p0781 H80-31269 SPACECRAPT CHARGING Environmental protection of the solar power	Application of battery reconditioning techniques to achieve capacity restoration - A case history
satellite p0609 180-46899	Ni-Cd cell performance improvement for spacecraft applications p0769 A80-48397
SPACECRAFT CONTROL  Dynamics and control of a continuum model for a  solar power system	Nickel-cadmium batteries for the Modular Power Subsystem of Multimission Modular Spacecraft
[AIAA 80-1740] p0757 A80-45534 SPACECRAPT LAUNCHING A study of the applicability/compatibility of	p0769 A80-48398 Performance of the recently developed Ni-Cd cells for the ETS-III batteries
inertial energy storage systems to future space missions	p0769 180-48399 Linear constraints aid selection of battery charge
[NASA-CR-163584] p0777 N80-32856 SPACECRAPT HODUES Wishelphydronon battery integration study for the	control parameters for orbiting spacecraft power supplies p0769 A80-48400
Fickel-hydrogen battery integration study for the Multimission Modular Spacecraft p0770 A80-48441	An accelerated test design for use with synchronous orbit on Wi-Cd cell degradation
SPACECRAFT POWER SUPPLIES  Cycles till failure of silver-zinc cells with	behavior p0770 A80-48401
competing failure modes - Preliminary data analysis p0761 A80-46414	Status of COMSAT/INTELSAT nickel-hydrogen battery technology p0770 A80-48437
Photovoltaic power generators in space p0604 A80-46735	Nickel-hydrogen batteries for INTELSAT V p0770 A80-48438
Puture space power - The D.O.D. perspective p0722 A80-48174	Nickel hydrogen battery advanced development program status report p0770 A80-48439
Computer simulation of solar panel voltage regulation p0612 A80-48177	Nickel hydrogen battery for a spacecraft power subsystem
GaAs solar cells for space applications p0613 A80-48203	p0770 A80-48440 Nickel-hydrogen battery integration study for the
The applicability of DOE solar cell and array technology to space power p0613 A80-48206	Multimission Modular Spacecraft p0770 A80-48441 Life cycle test of Air Force nickel-bydrogen
High-efficiency concentration/multi-solar-cell system for orbital power generation	flight experiment battery p0771 A80-48443
p0614 A80-48207 Solar thermophotovcltaic space power system p0614 A80-48208	Cycling characteristics of nickel-hydrogen cells p0771 A80-48444 Establishment of parameters for production of long
Concentrating photovoltaics - A viable candidate for the next generation of Air Porce satellite	life nickel oxide electrodes for nickel-hydrogen cells
power systems p0614 A80-48209 Concentrator-enhanced photovoltaic arrays for deep	p0771 A80-48445 Test data analysis and application of nickel hydrogen cells
space applications p0614 A80-48210 Heat-rejection design for large concentrating	p0771 A80-48446 Stirling engine power system development and test results
solar arrays p0614 A80-48211 Design and flight performance of the Pioneer Venus	p0731 A80-48453 Nickel-zinc batteries for aircraft and aerospace applications
Bultiprobe and Orbiter solar arrays p0614 A80-48212	p0772 A80-48483 Hybrid lithium/nickel-zinc large missile ground
Insat-I solar array - Design and development summary p0615 180-48213 Large area flexible solar array design for Space	power source p0772 A80-48489 The power system of the Aryabhata satellite
Shuttle application p0615 A80-48214	p0743 N80-29387 Synchronous Energy Technology
High voltage power systems for military needs solar energy conversion equipment p0725 A80-48254	[NASA-CP-2154] p0656 N80-33465 Toroidal cell and battery energy storage for orbital space applications or power cells for
go/20 200 10234	electric vehicles [HASA-CASE-LEW-12918-1] p0780 880-33857

SUBJECT INDEX STRAM

Lead batteries. Citations from the NTIS data base [PB80-813363] · P0780 N80-33923 SPILLING The fate and effects of crude oil spilled on subarctic permafrost terrain in interior Alaska [PB80-187305] p0585 #80-31984 SPACBLAB Study on the utilization of solar energy for the operation of Spacelab material science furnaces [BSA-CR(P)-1301] p0640-880-30348 Perspectives on research on LNG vapor cloud dispersion SPACELAB PAYLOADS p0590 N80-33593 Prospects for using solar energy to power materials-science furnaces in space SPIRALS Pressure loss in a spiral solar energy collector p0599 A80-46688 p0624 A80-50971 Study on the utilization of solar energy for the operation of Spacelab material science furnaces SPOILERS Peasibility studies of spoiler and aileron control systems for large horizontal-axis wind turbines p0727 A80-48318 LEDA-CE (P) -1301] p0640 880-30348 Study on the utilization of solar energy for the operation of Spacelab material science furnaces [DS-ERT-21-79] SPRAYED COATINGS An S.B.M. study of thin films made by spray pyrolysis --- CdS deposition on solar SPALLING photovoltaic panels A water-influx model for UCG with spalling-enhanced drying --- Underground Coal Plasma-sprayed coatings for very high temperature solar absorbers
[CONF-791021-3] p0631 N80-28 Gasification p0676 A80-48343 SPECTRAL EMERGY DISTRIBUTION p0631 N80-28875 Determination of the spectral distribution of global radiation with a rapid spectral radiometer and its correlation with solar cell SPUTTERING Schottky barriers on sputtered hydrogenated amorphous silicon - Photovoltaic properties and capacitance-voltage characteristics efficiency p0608 A80-46789 Standard procedures for terrestrial photovoltaic p0602 A80-46720 Contact formation, scaling and optimisation of large-area B.F. sputtered a-Si Schottky barrier performance measurements: Specification no. 101 [EUR-6423EN] p0637 N80-29877 Spectral character of solar and circumsolar radiation --- for application to concentrating solar energy systems p0602 A80-46721 Reactively sputtered thin film cu/sub x/S/CdS photovoltaic devices [LBL-10802] p0653 N80-32916 [UCID-18592] The SWAB (Spectral Wave And Bar) program
[PB80-196041] p07 Controlled cadmium telluride thin films for solar cell applications (emerging materials systems for solar cell applications) p0714 N80-34052 SPECTRAL LIBE WIDTH Use of generalized population ratios to obtain Fe XV line intensities and linewidths at high [ DOE/ET-23023/T3] p0642 N80-30921 STABILITY electron densities Preparation and stability of emulsions of methanol in automobile diesel oil p0735 A80-48763 SPECTRAL REPLECTANCE [CSIR-CBNG-294] p0713 N80-33579 Spectral effects on direct-insolation absorptance of five collector coatings
[ASME PAPER 79-HT-18] p0597 A80-45 STACKS Improvement in stacking structures of fuel cells p0726 A80-48283 Advanced thin silicon solar cell with controlled optical absorptance --- for space power systems STAGNATION PRESSURB The operating region of BHD generators and arrays p0739 A80-51721 p0601 A80-46710 STANDARDIZATION Reflectance measurements on laser-produced plasmas Standard procedures for terrestrial photovoltaic performance measurements: Specification no. 101 [BUR-6423BN] p0637 N80-29877 at 0.26 micron p0741 A80-53E70 SPECTRAL SENSITIVITY STANDARDS Spectral effects on direct-insolation absorptance of five collector coatings
[ASME PAPER 79-HT-18] p0597 A80-45
The spectral response of CdS:Cu/x/s solar cells Photovoltaic institutional issues study Environmental assessment. Energy efficiency standards for consumer products

[DOE/CS-01681] p0597 A80-45722 formed by dry barrier techniques [ DOE/CS-0168] STATE VECTORS D0597 A80-46251 Pulsed measurement of solar cell spectral response A state space analysis of a symmetrical compounded p0604 A80-46737 free piston Stirling engine Temperature effects in silicon solar cells p0734 A80-48498 p0624 A80-51115 STATIC LOADS An evaluation of spectrally selective reflectors Static investigation of rotor blades at rest and (cold mirror membranes) for use with concentrator solar arrays under quasi-stationary loading [ISD-243] p0747 N80-30948 p0659 N80-33900 STATISTICAL ABALYSIS Analysis of the influence of geography and weather on parabolic trough solar collector design SPECTEORADIOMETERS Determination of the spectral distribution of [ SAND-79-2032] global radiation with a rapid spectral radiometer and its correlation with solar cell p0631 N80-28876 efficiency Status of the Ford program to evaluate ceramics D0608 A80-46789 for stator applications in automotive gas SPECULAR REPLECTION turbine engines Reflectance measurements on laser-produced plasmas. p0720 A80-45375 at 0.26 micron STEADY STATE p0741 A80-53670 Conceptual design of RST: An rf-driven, SPENT PURLS steady-state Tokamak [BPRI-AP-1351] Overview of nuclear fuel cycle [CONF-791185-3] p0751 N80-32233 p0698 N80-30171 STEAM Assumptions and ground rules used in nuclear waste A problem posed by vapour-dominated geothermal projections and source term data systems [ONUI-24] p0689 A80-54063 p0585 N80-32203 SPHERICAL CAPS A parametric study of 1000 MWe combined closed cycle HHD/system electrical power generating High concentration solar collector of the stepped spherical type - Optical design characteristics plants p0629 A80-53263 [TH-78-E-91]

STRAN TURBINES SUBJECT INDEX

	STORAGE BATTERIES
Power production from geothermal brine with the	Batteries for solar electricity
rotary separator turbine	p0605 A80-4674
p0725 A80-48266 Thermionic topping of combined cycle powerplants	Recent progress in lithium/iron sulfide battery development
and cogeneration applications	p0762 180-4818
p0730 A80-48423	Cycle life studies of Lill/PeS cells using BN felt
Cogeneration Technology Alternatives Study (CTAS).	separators
Volume 3: Energy conversion system	p0763 A80-4818
characteristics	Optimization studies of lithium/iron sulfide cells
[ NASA-CR-159761] p0748 880-31869	for electric vehicle applications p0763 A80-4819
Combined cycle solar central receiver hybrid power system study. Volume 1: Executive summary	New approach to electrode current collection for
[DOE/ET-21050/1-1] p0586 H80-32867	LiAl/iron sulfide cells
Combined cycle solar central receiver hybrid power	p0763 A80-4819
system study, volume 2	Development of a tubular lithium-iron sulfide cell
[DOB/ET-21050/1-2] p0586 H80-32868	p0763 A80-4819
Combined cycle solar central receiver hybrid power	Scaling up of bipolar lithium/iron disulfide cells
system study. Volume 3: Appendices [DOE/ET-21050/1-3-VOL-3] p0587 H80-32893	p0763 A80-4819. Sodium-sulfur-aluminum chloride cells
STERIS	p0764 A80-4823
High temperature thermal energy storage in steel	Calcium/iron disulfide secondary cells
and sand	p0764 A80-4823
[HASA-CR-159708] p0776 H80-29860	Status of electrochemical energy storage systems
STILLS	for electric vehicle, solar, and electric
Hydrothermal energy: A source of energy for	utility applications
alcohol production [CONP-800526-1] p0698 N80-29869	p0765 180-4832
[CONF-800526-1] p0698 N80-29869 STIRLING CYCLE	Low maintenance lead-acid batteries for energy storage
Analysis and design of free-piston Stirling	p0765 180-4832
engines - Thermodynamics and dynamics	Nickel hydrogen battery for load leveling
p0729 A80-48407	application
Harmonic analysis of Stirling engine thermodynamics	p0766 A80-4832
p0730 A80-48408	Sandia battery program for energy storage in
Performance loss due to transient heat transfer in	photovoltaic systems p0767 A80-4836
the cylinders of Stirling engines	Development of a bipolar Zn/Br2 battery
An algorithm for the preliminary design of	p0767 A80-4836
Stirling engine beaters	Improvement and scale-up of the NASA Redox storage
p0730 A80-48411	system
Analysis of a heat-activated Stirling heat pump	p0767 A80-4837
p0730 A80-48424	Performance and structural characteristics of the
Development of a diaphragm Stirling engine	iron-air battery system for electric vehicle
heat-actuated heat pump p0731 A80-48425	propulsion p0767 A80-4837
Design characteristics and test results of the	Linear constraints aid selection of battery charge
United Stirling P40 engine	control parameters for orbiting spacecraft
p0731 A80-48452	power supplies
Stirling engine power system development and test	p0769 A80-4840
results	The lithium-sulfuryl chloride battery - Discharge
p0731 A80-48453 Stirling engines for developing countries	behaviour p0772 A80-48770
p0732 A80-48454	Vehicles testing of near-term batteries
Applications of free-piston Stirling engines	[SAE PAPER 800201] p0773 A80-4973
p0732 A80-48456	'Biperonnage' makes an electric car practical with
An advanced 15 kW solar powered free-piston	existing batteries recharging during periods
Stirling engine	of non-use
p0619 A80-48467 Validation of published Stirling engine design	[SAE PAPES 800204] p0773 A80-4973 Behavior of secondary lithium and aluminum-lithium
methods using engine characteristics from the	electrodes in propylene carbonate
literature	p0774 A80-5169
	STORAGE TARKS
A state space analysis of a symmetrical compounded	Performance of an inlet manifold for a stratified
free piston Stirling engine	storage tank
p0734 A80-48498	[ASME PAPER 79-HT-67] p0597 A80-45720
Investigation of a Philips MP 1002 CA Stirling	Sizing procedure and economic optimization methodology for seasonal storage solar systems
engine p0734 180-48499	A80-4657
Hodal analysis of miniature cryogenic coolers	A system consideration of alternative hydrogen
p0734 A80-48500	storage facilities for estimation of storage costs
An analytical solution for a Stirling machine with	p0661 A80-4766
an adiabatic cylinder	Internally insulated thermal storage system
p0734 A80-48501	development program [SAND-80-8175] p0775 B80-2892
Regenerative engines with dense phase working fluids - The Malone cycle	[SAND-80-8175] p0775 N80-28924 Solar domestic hot water system, a comparative
p0734 A80-48502	study and storage tank investigation
Design and development of Stirling engines for	p0643 N80-3186
stationary power applications in the 500 to 3000	STRAIN GAGES
hp range. Subtask 1A report: State-of-the-art	Comparison with strain gage data of centrifugal
conceptual design	stresses predicted by finite element analysis on
[DOB/ET-15209/T1] p0744 H80-30755	the DOB/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-28756
Design and development of Stirling engines for stationary power generation applications in the	[5AND-79-1990] p0741 N80-28750 STRATIFIED PLOW
500 to 3000 horsepower range	Performance of an inlet manifold for a stratified
[DOE/ET-15207/T1] p0752 #80-32723	storage tank
STOCHASTIC PROCESSES	[ASME PAPER 79-HT-67] p0597 A80-4572
	STRESS AWALYSIS
performance for water heating	Rotating strength of laminated composite discs

SUBJECT INDEX SULPUR OXIDE:

•	
STRIP MINING	SUBARCTIC REGIONS
The direct use of coal. Volume 2, part D:	The fate and effects of crude oil spilled on
Norking papers, appendices 15-17	subarctic permafrost terrain in interior Alaska
[PB80-184542] p0697 M80-29523 STRUCTURAL DESIGN	[PB80-187305] p0585 N80-31984
	SUBSTRATES  Positively court oned thin film on (sph w/5/645)
Computer aided optimal design of compressed air	Reactively sputtered thin film cu/sub x/S/CdS photovoltaic devices
energy storage systems p0761 180-45826	[UCID-18592] p0637 N80-29875
Bigh efficiency silicon solar cell for	Controlled cadmium telluride thin films for solar
concentrator systems	cell applications (emerging materials systems
p0606 A80-46767	for solar cell applications)
The commercial application of an OTEC Jacket	[DOE/ET-23023/T3] p0642 N80-30921
/tower/ design	SUGAR BEETS
p0728 A80-48350	Hydrothermal energy: A source of energy for
The optimal interconnection of solar collectors in	alcohol production
air heating systems with large collector surfaces	[COMP-800526-1] p0698 N80-29869
p0620 A80-48794	SUGAR CARE
Conceptual design study of concentrator enhanced	Production of sugarcane and tropical grasses as a
solar arrays for space applications. 2kW Si and	renewable energy source
Gals systems at 1 AU	[ORO-5912-T3] p0699 N80-30543
[NASA-CR-163046] p0630 N80-28863	SULPATES
Design and fabrication of a low cost Darrieus	A hybrid water-splitting cycle using copper
vertical axis wind turbine system, phase 1	sulfate and mixed copper oxides
[ALO-4272-T2] p0578 N80-28888	p0664 A80-48503
An investigation of wind loads on solar collectors	Sulfate aerosol production and growth in
[PB80-158744] p0633 N80-28936	coal-operated power plant plumes
An investigation of wind loads on solar	p0572 A80-48533
collectors. Appendix 1: Data listing for top	Sulfate in diesel exhaust
and bottom of collector	p0575 A80-50528
[PB80-158751] p0633 N80-28937	Formation of sulfate particles in the plume of the
Simplified energy design economics: Principles of	Pour Corners Power Plant
economics applied to energy conservation and	p0576 A80-51660
solar energy investments in buildings	SULPATION
[PB80-179245] p0634 H80-29534	Bydration of 'spent' limestone and dolomite to
Study of power management technology for orbital	enhance sulfation in fluidized-bed combustion
multi-100KWe applications. Volume 3:	p0672 A80-48172
Requirements	SOLPOR
[NASA-CR-159834] p0759 N80-29845	Recent progress on the sulfur cycle hybrid
Development of an 8 kW wind turbine generator for	hydrogen production process
residential type application. Phase 1: Design	p0663 A80-48460
and analysis. Volume 1: Executive summary	Shift conversion and methanation in coal
[DOE/DP-03533/T1-VOL-1] p0753 N80-32957	gasification: Bench-scale evaluation of a
STRUCTURAL DRSIGN CRITERIA	sulfur resistant catalyst
Experimental investigation of systems for	[FE-3240-T4] . r0692 N80-28561 Shift conversion and methanation in coal
diminishing the structural loads of large wind turbines	gasification: Bench-scale evaluation of a
p0722 A80-47600	
Static investigation of rotor blades at rest and	sulfur resistant catalyst [FE-3240-T5] p0696 N80-29509
under quasi-stationary loading	Investigation of sulfur-tolerant catalysts for
[ISD-243] p0747 N80-30948	selective synthesis of hydrocarbon liquids from
Design, engineering and evaluation of refractory	coal-derived gases
liners for slagging gasifiers	[FE-14809-1] p0702 N80-31502
[IITRI-M6043-5] p0704 N80-31640	Assessment of sulfur removal processes for
Photovoltaic module electrical termination design	advanced fuel cell systems
requirement study	[BPRI-EM-1333] p0752 N80-32866
[JPL-955367-80/1] p0644 N80-31877	SULFUR COMPOUNDS
STRUCTURAL ENGINEERING	Some chemistry in the Li/SOC12 cell
Mini-CTEC	p0774 A80-51688
p0740 A80-53473	Assessment of sulfur removal processes for
The Cold Nater Pipe - Ocean engineering status and	advanced fuel cell systems
developments	[EPRI-EN-1333] p0752 N80-32866
p0740 A80-53684	SULPUR DIOXIDES
Advanced development of a short-residence-time	A study of the gaseous and particulate pollutants.
hydrogasifier	in the environment of a thermal power plant
[FE-3125-12] p0704 N80-31638	project area
Advanced development of a short-residence-time	pus/u A80-46150
hydrogasifier	Sulfate aerosol production and growth in
[FE-3125-18] p0704 N80-31639	coal-operated power plant plumes
STRUCTURAL RELIABILITY Performance and structural characteristics of the	p0572 A80-48533 Safety studies on Li/SO2 cells. IV -
iron-air battery system for electric vehicle propulsion	Investigations of alternate organic electrolytes for improved safety
p0767 A80-48371	p0737 A80-50507
STRUCTURAL STABILITY	Safety studies on Li/SO2 cells. V - Effect of
Parabolic trough solar collector wind loading	design variables on the abuse resistance of
[SAND-79-2134C] p0652 N80-32895	hermetic D cells
STRUCTURAL STRAIR	p0737 A80-50509
Combined effects of periodic and stochastic loads	A study on utilizing solar energy for hydrogen
on the fatigue of wind turbine parts, part 6	production
[FFA-AU-1499-PT-6] p0741 N80-28732	p0665 A80-53569
STRUCTURAL VIBRATION	SULPUR OXIDES
Tests of a lightweight 200 kW MHD channel and	Determination of air pollutant emission factors
diffuser	for thermal tertiary oil recovery operations in
[AD-A087022] p0751 N80-32226	California, volume 1
STORE-LICUVILLE THEORY	[PB80-187594] p0585 N80-31982
Eigenvalue bounds for Hill's equation in	Determination of air pollutant emission factors
stability theory for magnetohydrodynamic	for thermal tertiary oil recovery operations in
equilibria	California. Volume 2: Appendix
p0720 A80-45851	[FB80-187602] p0585 N80-31983

SULPURIC ACID SUBJECT INDEX

SULPURIC ACID	SURPACE VEHICLES
Development status and utility of the sulfuric acid chemical heat pump/chemical energy storage	Requirements for materials for land vehicle gas turbines
system p0765 A80-48288	P0743 N80-2934
Sulfuric acid and water chemical heat	Preliminary study of the potential environmental
pump/chemical energy storage program, phase 2-A	concerns associated with surface waters and
[SAND-78-8176] p0776 N80-30924	geothermal development of the Valles Caldera
An improved synthesis of 2,4,8,10-tetroxaspiro	[LA-8398-MS] p0592 M80-3396
(5.5) undecane [NASA-CASE-ARC-11243-2] p0583 H80-31472	SURVEYS  Characteristics of the housing stock and
[NASA-CASE-ARC-11243-2] p0583 N80-31472 SUBLIGHT	Characteristics of the housing stock and households: Preliminary findings from the
Standard procedures for terrestrial photovoltaic	National Interim Energy Consumption Survey
performance measurements: Specification no. 101	p0579 N80-2983
[EUR-6423EN] p0637 N80-29877	SYECHROHOUS SATELLITES
Solar passive systems for buildings [NP-24377] p06#3 N80-30947	Electrical power subsystem for INSAT-I p0616 A80-4830
[NP-24377] p06A3 N80-30947 Terrestrial photovoltaic power systems with	STHTHAME
sunlight concentration	The HYGAS process to produce pipeline gas from coal
[SAND-80-7008] p0648 H80-31942	p0674 A80-4829
Analytical evaluation of a solar	The CS/R advanced SNG hydrogasification process
thermophotovoltaic converter [SAND-78-1962] p0649 N80-31954	p0674 A80-4829. The production of substitute natural gas and
SUPERCONDUCTING MAGNETS	recyclables from municipal solid waste
Internally cooled cabled superconductors. I	p0683 A80-4999
for applications to fusion reactors and MBD	Thermodynamic analysis of coal gasification
generators p0720 180-45054	processes p0686 A80-5121:
U.S./U.S.S.R. joint MHD generator testing at the	Liquid-phase methanol
U-25 MHD pilot plant	[EPRI-AF-1291] p0692 N80-2856
p0724 A80-48223	Assessment of Synthane mechanical equipment
Advanced designs for highly stable superconductor	[MTI-79TR5] p0710 N80-3257
systems [CONF-791102-148] p0748 N80-31253	SYNTHESIS (CHEMISTRY) Methanol and methyl fuel catalyst
Conceptual design of RST: An rf-driven,	[PE-3177-5] p0708 N80-3247
steady-state Tokamak	Alcohol fuels. Citations from the Engineering
[EPEI-AP-1351] p0751 880-32233	Index data base
SUPERCONDUCTING POWER TRANSMISSION	[PB80-812456] p0711 N80-3258. SENTERTIC FUELS
The dc superconducting power transmission line project at LASL: US DOE division of electric	Status of coal hydrogenation in Europe
energy systems	p0669 A80-4551
[LA-8323-PR] p0759 N80-30656	Peasibility of a peat biogasification process
Internally cooled cabled superconductors. I	p0669 A80-4619 Perspective on the DOB fusion synthetic fuels
for applications to fusion reactors and MBD	program
generators	p0677 A80-4840
p0720 A80-45054	The fusion-synfuel tie producing hydrogen with the
Advanced designs for highly stable superconductor systems	Tandem Mirror Reactor p0662 A80-4840.
[CONF-791102-148] p0748 N80-31253	Scoping study of a tandem-mirror fusion reactor
SUPERSONIC PLON	coupled to a thermochemical hydrogen synfuel plant
Pseudo-shock as a qualitative model in the investigation of the influence of wall roughness	p0662 A80-48400 Development of a falling-bed fusion blanket system
on the performance of supersonic MHD generators	for synthetic fuel production
[AD-A088333] p0754 N80-33228	p0678 A80-4844
SUPPLYING	High-temperature fusion blanket for a synthetic
The economics of energy prices - Doubts and uncertainty	fuel plant p0663 A80-4845
p0573 A80-49396	The producing mechanism, separative and fuel
Market penetration of energy supply technologies	characteristics of municipal refuse
p0579 N80-29637	p0679 A80-49539
A study of industrial hydrogen and syngas supply systems	Comparison of alternate aviation fuels [SAE PAPER 800767] p0680 A80-4971
[NASA-CR-163523] p0666 N80-31624	Efficiency of coal use, electricity for EVs versus
SURFACE DIFFUSION	synfuels for ICEs
Improvement of phosphorus diffused silicon solar	[SAE PAPER 800109] p0680 A80-4972
cells by laser treatment	Refuse to fuels - An appraisal of thermal processes p0684 A80-5001
SURFACE PROPERTIES	Pluidized bed combustion of refuse derived fuels
An emissometer with high accuracy for	p0684 A80-50019
determination of the total hemispherical	Potentialities and limitations of future use of
emittance of surfaces of solar energy absorbers	coal for power generation p0685 A80-5081
p0621 A80-48947	Energy choices and environmental constraints
SURFACE REACTIONS	p0576 A80-5193
Surface passivation of inversion layer m.i.s.	<pre>UK Department of Energy Solar Biological Programme - Biofuels</pre>
solar cells p0612 A80-48150	- Biorueis p0687 A80-5285
Analytical prediction of the performance of an air	Research, development, and commercialization
photovoltaic/thermal flat plate collector	activities on biomass energy in the United States
[DOE/ET-20279/93] p0653 N80-32914	p0687 A80-5285
SURFACE TEMPERATURE Geological and geothermal data use investigations	Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes
for application Explorer mission-A (heat	[FE-2315-40] p0691 N80-28550
capacity mapping mission)	Development of alcohol-based synthetic
[E80-10279] p3698 N80-29822	transportation fuels from coal-derived synthesis
	gases   nor/rr-14858/111

SUBJECT INDEX SYSTEMS ENGINEERING

Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3] p0630 N80-28569 Production of synthetic liquids from coal, 1980 -Satellite Power Systems (SPS) concept definition study. Volume 7: System/Subsystem requirements study. Vo data book p0759 N80-30900 [NASA-CR-3324] 2000. Freliminary study of potential impediments [FE-3137-T1] p0696 N80-29510 Research and development of an advanced process Peasibility study: Fuel cell cogeneration in a water pollution control facility, volume 1 [ DOE/ET-12431/T1-VOL-1] p0749 N80-31922 for the conversion of coal to synthetic gasoline methodology for the environmental assessment of and other distillate fuels advanced coal extraction systems [NASA-CR-163570] p0696 N80-29513 [FE-2306-38]
Environmental data energy technology characteristics: Synthetic fuels p0586 N80-32827 Satellite power system (SPS) concept definition study. Volume 3: Experimental verification study. [DUE/EV-0073] p0579 N80-29516
Refining and upgrading of synfuels from coal and
oil shales by advanced catalytic processes.
Laboratory and pilot plant definition [ NASA-CR-3320 ] [NASA-CR-3320] p0651 N80-32860 National Photovoltaics Program and applications experiments in the intermediate sector [SAND-80-0587C] p06 Laboratory and pilot plant studies of the p0654 N80-32935 processing of SRC-1 [FE-2315-45] Simulation of the energy-industry-environment p0699 N80-30544 system for limited economic regions, using the example of Baden-Wuerttemberg. Part 1: Data, Comparative assessment of five long-run energy projections [DOB/EIA/CB-0016/02] p0582 N80-3: A study of industrial hydrogen and syngas supply p0582 N80-30936 model development adaptation [IKE-K-54-20-PT-1] Systems assessment of heavy ion beam fusion drivers [ICE/DP-40039] p0754 N80-33247 p0666 N80-31624 [NASA-CR-163523] p0666 N80-31
Refining and upgrading of synfuels from coal and
oil shales by advanced catalytic processes SYSTEMS ENGINEERING Computer aided optimal design of compressed air p0703 N80-31629 [FE-2315-48] energy storage systems Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels p0761 A80-45826 An environmental assessment of the satellite power system reference design [FE-1800-45] p0704 N80-31641 Gasification of coal with solar energy [UCBL-84458] The design of photovoltaic systems for residential applications in the United States Gasilication of coal with solar energy poeus 180-31652 [UCBL-84458] synthetic fuels from municipal, industrial, and D0602 A80-46716 agricultural wastes. Citations from the NTIS Study of a hydro-photovoltaic plant for peak power data base generation in central and northern European [PB80-811375] p0706 N80-31660 countries Possil energy program [ORNL-5630] p0605 A80-46746 [ORNL-5630] p0707 N80-31902 Synthetic fuels from US oil shales: A technical and economic verification of the HYTORT process Advanced battery development at General Electric p0764 A80-48234 A six kilowatt transformer-coupled converter for [DOE/BT-14102/3] p0710 N80-32567 Space Shuttle solar power systems Advanced synfuels production/power systems utilizing laser particulate control p0616 A80-48262 Design and performance of the International Sun-Earth Explorer power systems [BNL-27783] p0710 N80-32570 p0765 A80-48307 Synthetic fuels from municipal, industrial and agricultural wastes. Citations from the American Petroleum Institute data tase Design, performance and life cycle cost relationships for a 500kW space solar array p0711 N80-32579 [PB80-812365] p0617 A80-48356 Fusion: An energy source for synthetic fuels
[BHI-27891] p0667 M80-33205
Oversight: Alternate liquid fuels technology
[GPO-50-313] p0590 M80-33580 System design of The Electric Test Vehicle - One /ETV-1/ [SAE PAPER 800057] p0772 A80-49718 Satellite power systems for Western Europe -Oversight: Cost estimation techniques for Problems and solution proposals emerging synthetic fuels technology, volume 9 [GPO-51-721] p0590 N80p0622 A80-50633 p0590 N80-33581 The solar power satellite concept -The past Energy policy: [GPO-56-541] Supply and demand alternatives decade and the next decade p0591 N80-33870 p0623 A80-50951 SYSTEM EFFECTIVENESS A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs Modelling the competitiveness of first generation commercial OTEC power plants p0624 A80-50968 p0718 A80-44605 Residential photovoltaic flywheel storage system OTEC power system modeling, analysis and design via geometric programming performance and cost p0739 A80-52048 p0768 A80-48377 Energy expenditure for environmental protection -SOLARES orbiting mirror system
[AAS 79-304] D0626 A80-52280 A contribution to efficiency analysis Relative merits of alternate linking techniques p0575 A80-50819 for underground coal gasification and their The usefulness of 'alternative' energy sources from the economic and energetic point of view p0685 A80-50823 system design implications p0688 A80-52969 High concentration solar collector of the stepped Solar energy system performance evaluation report for IBM System 3, Glendo, Wyoming [NASA-CR-161520] p0641 N80-308 Solar domestic hot water system, a comparative spherical type - Optical design characteristics p0629 A80-53263 DAM-ATOLL - A system for extracting energy from p0641 N80-30896 ocean waves study and storage tank investigation p0740 A80-53679 p0643 N80-31868 Optimum OTEC design and sensitivity analysis using geometric programming SYSTEMS ANALYSIS Environmental control technology for atmospheric carbon dioxide Cryogenic methane separation/catalytic P0569 A80-45300 hydrogasification process analysis [FE-3044-T6] p0690 N80-28548 Steps to system analysis in waste management p0574 A80-49932 OTEC cold water pipe design for problems caused by vortex-excited oscillations Analysis of solar collector array systems using [AD-A084555] thermography
[SERI/TR-351-494] p0741 N80-28867 Active solar energy system design practice manual [SOLAB/0802-79/01] p0632 N80-28889 p0632 N80-28894

SUBJECT INDEX SYSTEMS SIMULATION.

Investigation of methods to predict thermal	Cogeneration Technology Alternatives Study (CTAS).
stratification and its effect on solar energy	Volume 6: Computer data. Part 1: Coal-fired
system performance	nocogeneration process boiler, section B
[AD-A086051] p0636 H80-29864	[NASA-CR-159770-PT-1-B] p0745 N80-30889
Design of a photovoltaic system for a southwest	Cogeneration Technology Alternatives Study (CTAS).
all-electric residence	Volume 6: Computer data. Part 2:
[SAND-79-7056] p0637 N80-29876	Residual-fired nocogeneration process boiler
<ul> <li>Solar energy system performance evaluation report for IBM System 3, Glendo, Wyoming</li> </ul>	[HASA-CR-159770-PT-2] p0745 H80-30890
[NASA-CR-161520] p0641 N80-30896	Determination of air pollutant emission factors for thermal tertiary oil recovery operations in
Solar passive systems for buildings	California. Volume 2: Appendix
[NP-24377] p0643 N80-30947	[PB80-187602] p0585 N80-31983
Electric and hybrid vehicle system research and	Evaluation of cranking characteristics of
development project: Hybrid vehicle potential	commercially available batteries between room
assessment. Volume 1: Summary	temperature and -40 C
[CONS-4209-T1-VOI-1] p0583 N80-31272	[AD-A080614] p0780 H80-33906
Cryogenic methane separation/catalytic hydrogasification process analysis	Processing of coal, oil sand and heavy oil in situ
[PE-3044-17] p0704 B80-31635	by electric and magnetic fields
Hydrogen production by the GA sulfur-iodine process	p0669 A80-44846
[GA-A-15777-REV] p0666 880-31651	Recent activity in U.S. tar sand
Satellite power systems (SPS) concept definition	p0671 A80-48166
study. Volume 2, part 1: System engineering	Tar sands and heavy oil reservoir evaluation using
[NASA-CR-3318] p0760 N80-31890	geophysical well logs
A review of the methods for passive solar systems	p0671 A80-48167
analysis [AD-A087509] p0645 #80-31895	TECHNOLOGICAL PORECASTING Hid-range energy forecasting system - Structure,
General application of the critical path method to	forecasts, and critique
resource characterization and planning for	p0570 A80-46335
underground coal mining	The effect of demand uncertainty on the relative
[DOE/ET-11268/3] p0707 N80-32272	economics of electrical generation technologies
Coal demonstration plants	with differing lead times
[DOE/FE-0004/79-2] p0709 N80-32555 Development of an 8 kW wind turbine generator for	p0570 A80-46336 The potential global market in 2025 for Satellite
residential type application. Phase 1: Design	Solar Power Stations
and analysis. Volume 1: Executive summary	p0598 A80-46382
[DOE/DP-03533/T1-VOL-1] P0753 H80-32957	Solar power satellites - The present and the future
Air Porce space power technology program	p0757 A80-47562
p0782 N80-33468 Blectrochemical Orbital Energy Storage (ECOES)	Puture space power - The D.O.D. perspective
technology program regenerative fuel cell	p0722 A80-48174 The outlook for nuclear power
system	[PB80-175755] p0579 880-29156
p0780 N80-33473	Electric and hybrid vehicle system research and
tou-sect flaubool domencian browns	
Low-cost flywheel demonstration program	development project, hybrid vehicle potential
[CONS-5085-T2] p0780 N80-33909	assessment. Volume 6: Cost analysis
[CONS-5085-T2] p0780 N80-33909 SYSTEMS SIMULATION	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] p0583 N80-31274
[CONS-5085-T2] p0780 N80-33909 SYSTEMS SIMULATION Recent developments in the economic modeling of	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] p0583 N80-31274 Electric and hybrid vehicle system research and
[CONS-5085-T2] p0780 N80-33909 SISTEMS SIMULATION Recent developments in the economic modeling of photovoltaic module manufacturing	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential
[CONS-5085-T2] p0780 N80-33909 SYSTEMS SIMULATION Recent developments in the economic modeling of	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] p0583 N80-31274 Electric and hybrid vehicle system research and
[COMS-5085-T2] p0780 N80-33909  SISTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773  DEROB - A system for simulating the dynamic energy performance of passive solar structures	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] p0583 880-31275
[CONS-5085-T2] p0780 N80-33909  SISTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  p0607 A80-46773  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011	assessment. Volume 6: Cost analysis:  [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] POS83 N80-31275 TECHNOLOGY ASSESSMENT
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  p0607 A80-46773  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21]  A mathematical model for the continuous combustion	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] POS83 N80-31275 TECHNOLOGY ASSESSMENT A review of collector and energy storage
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773  DEBOB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] P0583 N80-31275 TECHNOLOGY ASSESSMENT A review of collector and energy storage technology for intermediate temperature
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  p0607 A80-46773  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21]  A mathematical model for the continuous combustion	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] POS83 N80-31275 TECHNOLOGY ASSESSMENT A review of collector and energy storage
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773  DEBOB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid bed combustor performance	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275 TECHNOLOGY ASSESSMENT A review of collector and energy storage technology for intermediate temperature applications  PO595 N80-45311 Status of coal hydrogenation in Europe
[CONS-5085-T2] p0780 N80-33909  SISTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized hed p0671 A80-48168  Selecting fines recycle methods to optimize fluid hed combustor performance  p0671 A80-48169	assessment. Volume 6: Cost analysis  [CONS-4209-T1-VOL-6] p0583 N80-31274  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] p0583 N80-31275  TECHNOLOGY ASSESSMENT  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  Status of coal hydrogenation in Europe p0669 A80-45512
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275 TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  PO595 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773  DEEOB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid ted combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage	assessment. Volume 6: Cost analysis  [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption  [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSMENT A review of collector and energy storage technology for intermediate temperature applications  PO595 N80-45311 Status of coal hydrogenation in Europe PO669 N80-45512 Status of coal hydrogenation outside Europe PO669 N80-45513
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311 Status of coal hydrogenation in Europe P0669 A80-45512 Status of coal hydrogenation outside Europe P0669 A80-45513 Progress in the development of the thin film HIS solar cell based on CdSe
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773  DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage p0765 A80-48241  Coal demonstration plants [DOS/FE-0004/79-2] p0709 880-32555	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] p0583 N80-31275  TECHNOLOGY ASSESSMENT A review of collector and energy storage technology for intermediate temperature applications  p0595 N80-45311 Status of coal hydrogenation in Europe p0669 N80-45512 Status of coal hydrogenation outside Europe p0669 N80-45513 Progress in the development of the thin film HIS solar cell based on CdSe
[CONS-5085-T2] p0780 N80-33909  SISTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773  DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage p0765 A80-48241  Coal demonstration plants [DOE/PE-0004/79-2] p0709 N80-32555  Study program for encapsulation materials	assessment. Volume 6: Cost analysis  [CONS-4209-T1-VOL-6] p0583 N80-31274  Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption  [CONS-4209-T1-VOL-8] p0583 N80-31275  TECHNOLOGY ASSESSMENT  A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  Status of coal hydrogenation in Europe  p0669 A80-45512  Status of coal hydrogenation outside Europe  p0669 A80-45513  Progress in the development of the thin film MIS solar cell based on CdSe  p0603 A80-46728  Photovoltaics commercialization readiness assessment
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21]  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  A model direct contact heat transfer for latent heat energy storage  [DOB/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] POS83 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  POS95 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe PO669 A80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment PO607 A80-46728
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASMF PAPEM 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants [DOE/PE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32857	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] p0583 880-31275  TECHNOLOGY ASSESSMENT A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311 Status of coal hydrogenation in Burope p0669 A80-45512 Status of coal hydrogenation outside Europe p0669 A80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment p0607 A80-46728 Component Development and Integration Facility - A
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21]  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  A model direct contact heat transfer for latent heat energy storage  [DOB/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array	assessment. Volume 6: Cost analysis  [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  **TECHNOLOGY ASSESSMENT**  A review of collector and energy storage technology for intermediate temperature applications  PO595 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe PO669 A80-45513  Progress in the development of the thin film MIS solar cell based on Cdse Photovoltaics commercialization readiness assessment PO607 A80-46772  Component Development and Integration Facility - A description and status report on coal-fired
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773  DEEOB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage p0765 A80-48241  Coal demonstration plants [DOE/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32857 Analytical studies of wind turbine turning	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] p0583 880-31275  TECHNOLOGY ASSESSMENT A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311 Status of coal hydrogenation in Burope p0669 A80-45512 Status of coal hydrogenation outside Europe p0669 A80-45513 Progress in the development of the thin film HIS solar cell based on CdSe Photovoltaics commercialization readiness assessment p0607 A80-46728 Photovoltaics commercialization readiness assessment p0607 A80-46772 Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773  DEEOB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid ted combustor performance p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage p0765 A80-48241  Coal demonstration plants [DOB/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] analytical studies of wind turbine turning characteristics [RIC-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITI	assessment. Volume 6: Cost analysis  [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  **TECHNOLOGY ASSESSMENT**  A review of collector and energy storage technology for intermediate temperature applications  PO595 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe PO669 A80-45513  Progress in the development of the thin film HIS solar cell based on Cdse PO603 A80-45513  Photovoltaics commercialization readiness assessment PO607 A80-46772  Photovoltaics commercialization readiness assessment Queen and Status report on coal-fired open cycle HHD plant  PO723 A80-48187  Recent progress in lithium/iron sulfide battery
[CONS-5085-T2] p0780 N80-33909  SISTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants  [DOB/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RIC-2439-79/3] p0753 N80-32951  SISTEMS STABILITY  Performance characteristics of nonequilibrium HHD	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311 Status of coal hydrogenation in Europe P0669 A80-45512 Status of coal hydrogenation outside Europe P0669 A80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment P0607 A80-46728 Photovoltaics commercialization readiness assessment P0607 A80-46772 Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant  P0723 A80-48187 Recent progress in lithium/iron sulfide battery development
[CONS-5085-T2] p0780 N80-33909  SISTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASMF PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants  [DOE/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RIC-2439-79/3] p0753 N80-32951  SISTEMS SYABILITY  Performance characteristics of nonequilibrium HHD generator with fully ionized seed and	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSERT A review of collector and energy storage technology for intermediate temperature applications  P0595 N80-45311 Status of coal hydrogenation in Europe P0669 N80-45512 Status of coal hydrogenation outside Europe P0669 N80-45513 Progress in the development of the thin film MIS solar cell based on Cdse P0603 N80-45513 Photovoltaics commercialization readiness assessment P0607 N80-46772 Component Development and Integration Facility - National description and status report on coal-fired open cycle MBD plant P0723 N80-48187 Recent progress in lithium/iron sulfide battery development
[CONS-5085-T2] p0780 N80-33909  SISTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants  [DOB/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RIC-2439-79/3] p0753 N80-32951  SISTEMS STABILITY  Performance characteristics of nonequilibrium HHD	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311 Status of coal hydrogenation in Europe P0669 A80-45512 Status of coal hydrogenation outside Europe P0669 A80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment P0607 A80-46728 Photovoltaics commercialization readiness assessment P0607 A80-46772 Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant  P0723 A80-48187 Recent progress in lithium/iron sulfide battery development
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage p0765 A80-48241  Coal demonstration plants  [DOE/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RIC-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITY  Performance characteristics of nonequilibrium BBD generator with fully ionized seed and enlargement of stabilized region  p0739 A80-51465  Advanced designs for highly stable superconductor	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  P0595 N80-45311 Status of coal hydrogenation in Europe P0669 N80-45512 Status of coal hydrogenation outside Europe P0669 N80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment P0607 N80-46772 Component Development and Integration Facility - National description and status report on coal-fired open cycle MBD plant  P0723 N80-48187 Recent progress in lithium/iron sulfide battery development  P0762 N80-48188 The 1980 technology status of the Dynamic Isotope Power System
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid ted combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants  [DOS/FE-0004/79-2] p0709 N80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RLC-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITY  Performance characteristics of nonequilibrium HHD generator with fully ionized seed and enlargement of stabilized region  p0739 A80-51465  Advanced designs for highly stable superconductor systems	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSMENT A review of collector and energy storage technology for intermediate temperature applications  PO595 N80-45311 Status of coal hydrogenation in Europe PO669 N80-45512 Status of coal hydrogenation outside Europe PO669 N80-45513 Progress in the development of the thin film HIS solar cell based on CdSe Photovoltaics commercialization readiness assessment PO603 N80-46728 Photovoltaics commercialization readiness assessment PO607 N80-46772 Component Development and Integration Facility - N description and status report on coal-fired open cycle HHD plant PO723 N80-48187 Recent progress in lithium/iron sulfide battery development  PO762 N80-48188 The 1980 technology status of the Dynamic Isotope Power System PO725 N80-48255 Interim status report on DOE prototype development
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage p0765 A80-48241  Coal demonstration plants  [DOE/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RIC-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITY  Performance characteristics of nonequilibrium BBD generator with fully ionized seed and enlargement of stabilized region  p0739 A80-51465  Advanced designs for highly stable superconductor	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  PO595 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe PO669 A80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment PO607 A80-46728 Photovoltaics commercialization readiness assessment PO607 A80-46772 Component Development and Integration facility - A description and status report on coal-fired open cycle MHD plant PO723 A80-48187 Recent progress in lithium/iron sulfide battery development The 1980 technology status of the Dynamic Isotope Power System PO725 'A80-48255 Interim status report on DOE prototype development SWECS Small Wind Energy Conversion Systems
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid ted combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants  [DOS/FE-0004/79-2] p0709 N80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RLC-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITY  Performance characteristics of nonequilibrium HHD generator with fully ionized seed and enlargement of stabilized region  p0739 A80-51465  Advanced designs for highly stable superconductor systems	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  p0595 N80-45311 Status of coal hydrogenation in Europe p0669 N80-45512 Status of coal hydrogenation outside Europe p0669 N80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment p0607 N80-46728 Photovoltaics commercialization readiness assessment p0607 N80-46772 Component Development and Integration Facility - A description and status report on coal-fired open cycle MBD plant  p0723 N80-48187 Recent progress in lithium/iron sulfide battery development  p0762 N80-48188 The 1980 technology status of the Dynamic Isotope Power System  p0725 N80-48255 Interim status report on DOE prototype development SWECS Small Wind Energy Conversion Systems
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid ted combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants  [DOS/FE-0004/79-2] p0709 N80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RLC-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITY  Performance characteristics of nonequilibrium HHD generator with fully ionized seed and enlargement of stabilized region  p0739 A80-51465  Advanced designs for highly stable superconductor systems	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  PO595 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe PO669 A80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment PO607 A80-46728 Photovoltaics commercialization readiness assessment PO607 A80-46772 Component Development and Integration facility - A description and status report on coal-fired open cycle MHD plant PO723 A80-48187 Recent progress in lithium/iron sulfide battery development The 1980 technology status of the Dynamic Isotope Power System PO725 'A80-48255 Interim status report on DOE prototype development SWECS Small Wind Energy Conversion Systems
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage p0765 A80-48241  Coal demonstration plants  [DOE/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RLO-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITY  Performance characteristics of nonequilibrium BHD generator with fully ionized seed and enlargement of stabilized region  Advanced designs for highly stable superconductor systems  [CONY-791102-148] p0748 B80-31253	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  PO595 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe PO669 A80-45513 Progress in the development of the thin film HIS solar cell based on Cdse Photovoltaics commercialization readiness assessment PO607 A80-46772 Component Development and Integration Facility - A description and status report on coal-fired open cycle HHD plant  PO723 A80-48187 Recent progress in lithium/iron sulfide battery development  PO62 A80-48188 The 1980 technology status of the Dynamic Isotope Power System  PO725 A80-48255 Interim status report on DOE prototype development SWECS Small Wind Energy Conversion Systems  PO726 A80-48270 Status of electrochemical energy storage systems for electric vehicle, solar, and electric utility applications
[CONS-5085-T2] p0780 N80-33909  SISTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized hed p0671 A80-48168  Selecting fines recycle methods to optimize fluid hed combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants  [DOB/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RIO-2439-79/3] p0753 N80-32951  SISTEMS SYMBILITI  Performance characteristics of nonequilibrium BBD generator with fully ionized seed and enlargement of stabilized region  p0739 A80-51465  Advanced designs for highly stable superconductor systems  [CONF-791102-148] p0748 B80-31253	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] p0583 N80-31275  TECHNOLOGY ASSESSMENT A review of collector and energy storage technology for intermediate temperature applications  Status of coal hydrogenation in Europe p0669 A80-45512 Status of coal hydrogenation outside Europe p0669 A80-45513 Progress in the development of the thin film HIS solar cell based on CdSe p0603 A80-45728 Photovoltaics commercialization readiness assessment p0607 A80-46772 Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant p0723 A80-48187 Recent progress in lithium/iron sulfide battery development The 1980 technology status of the Dynamic Isotope Power System p0725 A80-48255 Interim status report on DOE prototype development SWECS Small Wind Energy Conversion Systems p0726 A80-48270 Status of electrochemical energy storage systems for electric vehicle, solar, and electric utility applications
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  A model direct contact heat transfer for latent heat energy storage  Coal demonstration plants  [DOE/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [HASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RIC-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITY  Performance characteristics of nonequilibrium HHD generator with fully ionized seed and enlargement of stabilized region  Advanced designs for highly stable superconductor systems  [CONF-791102-148] p0748 B80-31253  T  TABLES (DATA)  International energy indicators  [DOE/IA-00011/3(80)] p0761 B80-28919	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  PO595 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe PO669 A80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment PO607 A80-46728 Photovoltaics commercialization readiness assessment PO607 A80-46772 Component Development and Integration Facility - A description and status report on coal-fired open cycle MBD plant PO723 A80-48187 Recent progress in lithium/iron sulfide battery development The 1980 technology status of the Dynamic Isotope Power System PO762 A80-48188 The 1980 technology status of the Dynamic Isotope Power System PO775 'A80-48255 Interim status report on DOE prototype development SWECS Small Wind Energy Conversion Systems PO726 A80-48270 Status of electrochemical energy storage systems for electric vehicle, solar, and electric utility applications PO765 A80-48325 Development status of the General Electric solid
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage p0765 A80-48241  Coal demonstration plants  [DOE/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RLC-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITY  Performance characteristics of nonequilibrium BHD generator with fully ionized seed and enlargement of stabilized region  Advanced designs for highly stable superconductor systems  [CONF-791102-148] p0748 N80-31253  T  TABLES (DATA)  International energy indicators  [DOE/IA-00011/3 (80)] p0761 N80-28919  Cogeneration Technology Alternatives Study (CTAS).	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  PO595 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe PO669 A80-45513 Progress in the development of the thin film HIS solar cell based on Cdse Photovoltaics commercialization readiness assessment PO607 A80-46772 Component Development and Integration Facility - A description and status report on coal-fired open cycle HBD plant  PO723 A80-48187 Recent progress in lithium/iron sulfide battery development  The 1980 technology status of the Dynamic Isotope Power System  PO762 A80-48188 The 1980 technology status of the Dynamic Isotope Power System  PO725 A80-48255 Interim status report on DOE prototype development SWECS Small Wind Energy Conversion Systems pO726 A80-48270 Status of electrochemical energy storage systems for electric vehicle, solar, and electric utility applications  Development status of the General Electric solid polymer electrolyte water electrolysis technology
[CONS-5085-T2] p0780 N80-33909  SYSTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized bed p0671 A80-48168  Selecting fines recycle methods to optimize fluid red combustor performance  A model direct contact heat transfer for latent heat energy storage  Coal demonstration plants  [DOE/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [HASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RLC-2439-79/3] p0753 N80-32951  SYSTEMS SYABILITY  Performance characteristics of nonequilibrium HHD generator with fully ionized seed and enlargement of stabilized region  Advanced designs for highly stable superconductor systems  [CONF-791102-148] p0748 B80-31253  T  TABLES (DATA)  International energy indicators  [DOE/IA-00011/3(80)]  Cogeneration Technology Alternatives Study (CTAS). Volume 6: Computer data. Part 1: Coal-fired nocogeneration process hoiler, section A	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] PO583 N80-31275  TECHNOLOGY ASSESSENT A review of collector and energy storage technology for intermediate temperature applications  PO595 A80-45311 Status of coal hydrogenation in Europe PO669 A80-45512 Status of coal hydrogenation outside Europe PO669 A80-45513 Progress in the development of the thin film MIS solar cell based on CdSe Photovoltaics commercialization readiness assessment PO607 A80-46728 Photovoltaics commercialization readiness assessment PO607 A80-46772 Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant PO723 A80-48187 Recent progress in lithium/iron sulfide battery development  The 1980 technology status of the Dynamic Isotope Power System PO725 A80-48255 Interim status report on DOE prototype development SWECS Small Wind Energy Conversion Systems PO726 A80-48270 Status of electrochemical energy storage systems for electric vehicle, solar, and electric utility applications  PO765 A80-48325 Development status of the General Electric solid polymer electrolyte water electrolysis technology PO662 A80-48413 Assessment of current research and development in
[CONS-5085-T2] p0780 N80-33909  SISTEMS SIMULATION  Recent developments in the economic modeling of photovoltaic module manufacturing  DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  A mathematical model for the continuous combustion of char particles in a fluidized hed p0671 A80-48168  Selecting fines recycle methods to optimize fluid hed combustor performance  p0671 A80-48169  A model direct contact heat transfer for latent heat energy storage  p0765 A80-48241  Coal demonstration plants  [DOE/FE-0004/79-2] p0709 B80-32555  Study program for encapsulation materials interface for low cost silicon solar array  [NASA-CR-163583] p0651 N80-32857  Analytical studies of wind turbine turning characteristics  [RIC-2439-79/3] p0753 N80-32951  SISTEMS SYABILITI  Performance characteristics of nonequilibrium BBD generator with fully ionized seed and enlargement of stabilized region  p0739 A80-51465  Advanced designs for highly stable superconductor systems  [CONF-791102-148] p0748 H80-31253  T  TABLES (DATA)  International energy indicators  [DOE/IA-00011/3(80)] p0761 B80-28919  Cogeneration Technology Alternatives Study (CTAS). volume 6: Computer data. Part 1: Coal-fired	assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation impact of hybrid vehicles on petroleum consumption [CONS-4209-T1-VOL-8] p0583 N80-31275  FECHNOLOGY ASSESSMENT A review of collector and energy storage technology for intermediate temperature applications  FOS95 A80-45311  Status of coal hydrogenation in Europe p0669 A80-45512  Status of coal hydrogenation outside Europe p0669 A80-45513  Progress in the development of the thin film HIS solar cell based on CdSe p0603 A80-46728  Photovoltaics commercialization readiness assessment p0607 A80-46772  Component Development and Integration Facility - A description and status report on coal-fired open cycle MHD plant p0723 A80-48187  Recent progress in lithium/iron sulfide battery development  The 1980 technology status of the Dynamic Isotope Power System p0725 A80-48255  Interim status report on DOE prototype development SWECS Small Wind Energy Conversion Systems p0726 A80-48270  Status of electrochemical energy storage systems for electric vehicle, solar, and electric utility applications  P0765 A80-48325  Development status of the General Electric solid polymer electrolyte water electrolysis technology p0662 A80-48413

p0677 180-48428

SUBJECT INDEX TECHNOLOGY UTILIZATION

Photovoltaic conversion - Recent progress in solid Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative state solar cells p0620 A80-48790 State and tendencies of recycling in Worth America p0573 A80-49929 Status report on the research programme technologies [NASI-CR-163049] p0750 N80-31951
California's biomass and its energy potential
[LBL-10058] p0709 N80-32564
Assessment of Synthane mechanical equipment processes of thermal waste treatment p0680 A80-49937 Strategies for rational utilization of bituminous coal deposits in the German Federal Republic p0710 180-32572 [HTI-79TR5] Use of solar energy to produce process heat for industry p0685 A80-50814 [ SERI/TP-731-626] Possible means of cutting energy costs and saving primary energy in waste water purification Residential photovoltaic flywheel storage system performance and cost p0575 A80-50818 [DOE/ET-20279/92] UK Department of Energy Solar Biological Programme Reference energy systems as applied to regional energy policy
[BNL-26987] p058
Photovoltaic applications definition and p0587 N80-32883 p0687 A80-52853 Photovoltaics in the U.S.A. - A progress report p0629 A80-52866 photovoltaic system definition study in the Tidal energy and the energy crisis - An assessment of technology and the interrelationship agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891 Costing methodologies for energy systems
[BNL-27603]
Assessment of hydrogen compressor technology for energy storage and transmission systems
[ORO-5598-T1]

p0667 M80-3 p0689 A80-53682 1979 status of the OTEC Environment Program p0577 A80-53689 p0778 N80-32900 Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TE-35-078-VOL-3] p0630 N80-28 p0667 N80-32922 [SERI/TE-35-078-VOL-3] p0630 N80-28569 Technical and economic feasibility of alternative Forecasts of energy technology. Citations from the International Aerospace Abstracts data base fuel use in process heaters and small toilers
[DOB/RIA-10547/01] p0693 N80-;
Alternative energy futures. Part 1: The future
of liquefied natural gas imports [ NASA-CR- 163596 ] p0782 N80-32965 p0693 180-28570 Assessment of environmental control technologies for energy storage systems, 1979 [LA-8308-MS] The future p0588 180-32973 p0693 N80-28574 [PB 80-173552] Environmental assessment report: Wellman-Galusha low-Btu gasification systems [FB80-190796] Long-term average performance benefits of parabolic trough improvements [SERI/TR-632-439] p0589 N80-32995 Synchronous energy technology program p0632 N80-28893 Laser technology: Development and applications p0657 180-33466 p0781 N80-29694 [GP0-59-826] NASA technology program overview Satellite Power Systems (SPS): Concept development and evaluation program: Preliminary p0782 N80-33467 State-of-the-art reviews and bibliographies on energy. Citations from the NTIS data base [PB00-812886] State-of-the-art reviews and bibliographies on energy. Citations from the NTIS data base [PB80-812894] assessment NASA-TH-81142] p0759 N80-29842 p0782 N80-33917 Selection of alternative central-station technologies for the Satellite Power System (SPS) comparative assessment p0782 N80-33918 [DOE/ER-0052] p0580 B80-29887 Conservation and solar energy programs of the Satellite Power System (SPS) PY 79 program summary [NASA-CR-163479] p0639 H80-29900 Department of Energy: A critique [ PB80-197759 ] p0591 N80-33922 Development of sodium sulfur batteries Assessment of H2S control technologies for p0776 N80-29905 geothermal power plants [PB80-193709] [BMPT-PB-T-79-60] Assessment of integrated urban energy options [PB80~173644] p0581 B86 p0593 N80-33973 p0581 B80-30234 Technology Assessment. Citations from the NTIS Solar power satellite offshore rectenna study
[NASA-CR-161543] p0759 N80-30891
Comparative analysis of net energy balance for data base [PB80-813165] p0783 M80-34299 Technology Assessment. Citations from the NTIS Satellite Power Systems (SPS) and other energy data base [PB80-813173] systems p0783 N80-34300 [ DOE/RR-0056 ] [DOE/RR-0056] p0582 N80-30916 Hybrid photovoltaic/thermal systems with a TECHNOLOGY TRANSPER Energy to the 21st century: Proceedings of the Fifteenth Intersociety Energy Conversion solar-assisted heat pump p0642 N80-30919 [BNI-27667] Engineering Conference, Seattle, Wash., August 18-22, 1980. Volumes 1, 2 and 3 Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's p0722 A80-48165 Energy conservation and environmental benefits of [CONF-790631-1] p0701 N80-30922 [CONF-790631-1] p0701 N80-30922
Photovoltaic systems and applications perspective
[SAND-80-0926C] p0582 N80-30923
Design study and economic assessment of multi-unit
offshore wind energy conversion systems
application. Volume 1: Executive summary
[WASH-2330-78/4-VOL-1] p0746 N80-30930
Puel cells for electric utility and transportation thermal energy storage systems in the pulp and paper industry Geological and geothermal data use investigations for application Explorer mission-A (heat capacity mapping mission)
[E80-10279] D0698 N80-29822 applications TECHNOLOGY UTILIZATION [BML-27452] p0747 880-30937 Thermally driven open-cycle heat pump system [COMP-800549-1] p0582 880-30938 p0747 N80-30937 A scheme for large scale desalination of sea water by solar energy Energy analysis program, PY 1979 [LBL-10320] The design, application benefits, and economics of energy-efficient motors - A technological update p0571 A80-47592 p0582 880-30942 Materials for coal conversion and use. Volume 2: Haterials of construction for coal conversion systems. Part 1: Coal gasification. Part 2: Coal liquefaction [PB-2468-59-VOL-2-PT-1/2] p0705 N80-3 The applicability of DOE solar cell and array technology to space power p0613 A80-48206 Intermediate load-center photovoltaic application [FE-2468-59-VOL-2-PT-1/2] p0705 H80-31644 Basic research needs and priorities in solar energy. Volume 1: Executive summary.
Technology crosscuts for DOE
[SERI/TR-351-358-VOL-1] p06 The commercial application of an OTEC Jacket p0645 N80-31898 /tower/ design Evaluation of line focus solar central power systems. Volume 1: Executive summary [ATR-80 (7773-03)-1-VOL-1] p0648 88 p0728 A80-48350

p0648 N80-31943

TEMPERATURE COSTROL SUBJECT INDEX

•	
Potentialities and limitations of future use of coal for power generation	Weld overlaying for corrosion resistance in coal gasification atmospheres
p0685 A80-50817 European technology applicable to Solar Power	[FE-2621-13] p0711 H80-32726 TERMIHALS
Satellite Systems (SPS) [INKA-CONF-79-378-046] p0637 #80-29878	Energy conservation in terminal airspace through fuel consumption modeling
TEMPERATURE CONTROL	[SAR PAPER 800745] p0573 A80-49695
Performance of storage walls with highly conductive covering plates and connecting fins [ASME PAPER 80-HT-18] p0762 A80-48009	TERRALE  Changes in the potential for wind energy  generation due to terrain modification of the
DEROB - A system for simulating the dynamic energy performance of passive solar structures	boundary-layer flow p0714 H80-34020
[ASME PAPER 80-HT-21] p0612 A80-48011 Pluid temperature control for parabolic trough	TRREALS ANALYSIS Summary of guidelines for siting wind turbine
Solar collectors [SAND-79-2006C] p0652 880-32894	generators relative to small-scale, two-dimensional terrain features [BLO-2443-77/1] p0647 M80-31930
TREPERATURE DEPENDENCE Thermionic converter output as a function of collector temperature	[BLO-2443-77/1] p0647 B80-31930 TBST PACILITIES The Tandem Mirror Pusion Test Facility
p0732 A80-48476	p0720 A80-45850
TEMPERATURE DISTRIBUTION  Numerical simulation of dual-media thermal energy  storage systems	Component Development and Integration Pacility - A description and status report on coal-fired open cycle MBD plant
[ASHE PAPER 79-HT-35] p0761 A80-45725	p0723 A80-48187
Convective-radiative interaction in a parallel plate channel - Application to air-operated solar collectors	U.S./U.S.S.R. joint MHD generator testing at the U-25 MHD pilot plant p0724 A80-48223
p0598 A80-46349 Transient thermal analysis of phase change thermal	A successful eastern in situ coal gasification field trial
energy storage systems [ASME PAPEE 80-HT-2] p0762 A80-48001	p0675 A80-48342 Improvement and scale-up of the NASA Redox storage
The use of refuse heat assisted by heat transformers p0686 A80-51499	system p0767 A80-48370
Thermographic techniques applied to solar collector systems analysis	An engineering development plan for inertial confinement fusion
[SERI/TP-351-540] P0655 H80-32946	p0733 A80-48496
TEMPERATURE REFECTS Temperature limitations of alkaline battery	Experimental investigation of the Trombe wall passive solar energy system
electrodes	p0627 A80-52833 TEST BANGES
Temperature:induced permeability alterations in unconsolidated and consolidated aguifer media	Ocean thermal energy conversion /OTEC/ - A subscale test range
for seasonal thermal energy storage p0766 A80-48336	p0740 A80-53674 TEST VEHICLES
Collector temperature effects on the performance of advanced thermionic converters and nuclear	System design of The Electric Test Vehicle - One /ETV-1/
electric propulsion systems p0730 A80-48421	[SAE PAPER 800057] p0772 A80-49718 THERMAL ABSORPTION
Safety studies on Li/SO2 cells. IV - Investigations of alternate organic electrolytes for improved safety	Theoretical study of absorbed solar energy in multi-layer absorber coatings for receivers of solar concentrators. II - Heat transfer analysis
p0737 180-50507 The solution to the gas turbine temperature problem	[ASME PAPER 80-HT-105] p0612 A80-48034 Ammonia/water absorption cycles with relatively
engine design p0738 180-50949	high generator temperatures p0625 A80-51682
Temperature effects in silicon solar cells p0624 A80-51115	THREMAL CONDUCTIVITY Investigation of methods to predict thermal
Plasma-sprayed coatings for very high temperature solar absorbers	stratification and its effect on solar energy system performance
[CONF-791021-3] p0631 N80-28875 TEMPERATURE GRADIENTS	[AD-A086051] p0636 B80-29864 Thermophysical properties of coal liquids
Investigation of methods to predict thermal stratification and its effect on solar energy	[BMI-2043] . p0701 M80-30557
stratification and its effect on solar energy system performance	THREMAL CYCLING TESTS  Thermal energy storage using Glauber's salt -
[AD-A086051] p0636 N80-29864 Sites for wind-power installations: Wind	Improved storage capacity with thermal cycling p0764 A80-48197
characteristics over ridges, part 2 [BLO-2438-78/2] p0706 B80-31901	Performance of the recently developed Ni-Cd cells for the BTS-III batteries
TRAPERATURE MEASUREMENT	p0769 A80-48399
An emissometer with high accuracy for determination of the total hemispherical	An investigation of the thermal energy storage capacity of Glauber's salt with respect to
emittance of surfaces of solar energy absorbers	thermal cycling p0774 A80-51683
p0621 A80-48947	Efficient thermal cycling of solar panels in solar
Analysis of solar collector array systems using thermography	simulation facilities with a multi-panel test rig p0659 N80-33898
[SERI/TR-351-494] p0632 N80-28894 TEMPERATURE PROFILES	THERMAL DECOMPOSITION . Solar retorting of oil shale
Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open	p0613 A80-48198 The MARK-13 process for hydrogen production
cycle MHD radiant boiler	p0662 A80-48412
[ASME PAPER 80-BI-44] p0722 A80-48022 Model of direct contact heat transfer for latent heat energy storage	THERMAL DEGRADATION  Performance of the recently developed Ni-Cd cells  for the ETS-III batteries
[SBRI/TP-631-567] p0779 N80-32955	p0769 A80-48399
TENSILE TESTS Haterial evaluation and testing program for OTEC	An accelerated test design for use with synchronous orbit on Bi-Cd cell degradation
riser cable p0728 A80-48351	behavior p0770 A80-48401
P0.50 B00-40331	Po 1 0 MOD-4040 1

SUBJECT INDEX THERMIONIC CONTRACTOR

THER BAL DIFFUSION	THERBAL INSULATION
A new diffusion process for silicon solar cells p0601 A80-46708	A study of the heat-induced fracture characteristics of materials under intense
THERMAL DISSOCIATION	radiant heating
Automotive storage of hydrogen using modified	p0609 A80-46815
magnesium hydrides [SAN-1167-1] p0666 N80-31650	Utilization of low temperature insulators and seals in thermionic converters
Hydrogen production by the GA sulfur-iodine process [GA-A-15777-REV] p0666 H80-31651	p0732 180-48474 Performance monitoring of low energy house,
THERMAL EMERGY  The tax on waste heat - An instrument of economic	Hacclesfield p0575 A80-50944
policy for preserving resources	Energy savings obtainable through passive solar
p0569 A80-44764 The layer perovskites as thermal energy storage	techniques [LA-UE-80-746] p0632 N80-28891
Systems	THERMAL MAPPING
p0761 A80-45315 'Transient thermal analysis of phase change thermal	Geological and geothermal data use investigations for application Explorer mission-A (heat
energy storage systems [ASHE PAPER 80-HT-2] p0762 A80-48001	capacity mapping mission) [B80-10279] p0698 N80-29822
Energy conservation and environmental benefits of	THERMAL RADIATION
thermal energy storage systems in the pulp and	An emissometer with high accuracy for
paper industry p0763 A80-48194 Bigh performance photovoltaic systems	<pre>determination of the total hemispherical   emittance of surfaces of solar energy   absorbers</pre>
p0616 A80-48233	p0621 A80-48947
Study of thermal energy storage using fluidized bed heat exchangers	THERMAL BEACTORS Refuse to fuels - An appraisal of thermal processes
p0764 A80-48240	p0684 A80-50011 THERMAL RESISTANCE
Experimental and theoretical studies of thermal energy storage in aguifers	Development of high temperature resistant, solar
p0766 A80-48334	absorber surfaces
Seasonal thermal energy storage of chilled water in aquifers	[BHFT-FB-T-79-70] p0640 N80-29906 THERNAL RESOURCES
p0766 A80-48335	Thermal resource availability ocean
Comparison of advanced engines for parabolic dish solar thermal power plants	temperature data base for OTEC purposes p0718 A80-44603
p0618 A80-48418 Thermal buffering of receivers for parabolic dish	THERMAL SIMULATION Transport code simulations of lower hybrid heating
solar thermal power plants	in tokamaks p0719 A80-44664
p0618 A80-48419 Analysis of a heat-activated Stirling heat pump p0730 A80-48424	THERMAL STABILITY Solar selective black cobalt - Preparation,
One megawatt /thermal/ bench model solar receiver design and test	structure, and thermal stability p0609 A80-46933
p0619 A80-48464	Optimum working fluids for solar powered Rankine
Cost and thermal performance comparisons for wall systems as applied to passive solar building	cycle cooling of buildings
p0628 A80-52842 Thermal energy storage systems using fluidized bed	Fuels research: Fuel thermal stability overview p0694 N80-29324
heat exchangers [NASA-CE-159868]	Mechanisms of nitrogen heterocycle influence on turbine fuel stability
Magma energy: A feasible alternative	p0695 N80-29327
[SAND-80-0309] p0693 N80-28874 Multiple-tank high temperature storage subsystem	THERMAL STRESSES Testing flat plate photovoltaic modules for
[SAND-79-2056] p0775 N80-28878	terrestrial environment
Electric utility solar energy activities: 1979survey	p0608 A80-46788 A study of the heat-induced fracture
[EPRI-ER-1299-SR] • p0631 880-28879	characteristics of materials under intense
Active heat exchange system development for latent	radiant heating p0609 A80-46815
heat thermal energy storage [NASA-CR-159727] p0775 N80-29857	Thermal stress in a composite cylinder by finite
Report of the 6th Ocean Thermal Energy Conversion	difference technique solar concentrator
Conference. Ocean Thermal Energy for the 1980's [CONF-790631-1] p0701 N80-30922	tubular heat exchanger [ASME PAPER 80-HT-107] p0612 A80-48036
Cogeneration Technology Alternatives Study (CTAS).	THERMAL VACUUM TESTS
Volume 3: Industrial processes [NASA-CR-159767] p0749 N80-31870	Efficient thermal cycling of solar panels in solar simulation facilities with a multi-panel test rig
Field experience with solar concentrating	p0659_N80-33898
collector control systems [SAND-79-2044C] p0647 N80-31924	THERMIONIC CATHODES  Beat flux at the thermionic collector
Analytical modeling of line focus solar collectors	p0732 A80-48477
[SERI/TP-333-591] p0647 N80-31926	THERMIONIC CONVENTERS
Thermal energy storage for building heating and cooling applications	Electric energy production by particle thermionic-thermoelectric power generators
[ORNL/TH-7319] p0777 N80-32879	p0729 A80-48387
Line-focus solar thermal energy technology development. Report for Department 4720	Collector temperature effects on the performance of advanced thermionic converters and nuclear
[SAND-80-0865-REV] p0651 N80-32887	electric propulsion systems
Potential for supplying solar thermal energy to industrial unit operations	p0730 A80-48421 Thermionic topping of combined cycle powerplants
[SERI/TP-632-584] p0588 N80-32911	and cogeneration applications
District heating and cooling systems for	p0730 A80-48423
communities through power plant retrofit distribution network, volume 4	Progress in the development of small flame heated thermionic energy converters
[COO-4977/1-VOL-4] p0753 x80-32942	p0732 A80-48472
	Combustion performance of CVD silicon carbide thermionic diodes Chemical Vapor Deposition
	p0732 A80-48473

Utilization of low temperature insulators and seals in thermionic converters	Thermodynamic analysis of the helium cycles of gas turbine nuclear power plants
p0732 A80-48474 Thermionic converter output as a function of collector temperature	p0721 A80-47080 Condenser designs for binary power cycles in geothermal energy conversion
p0732 A80-48476  Heat flux at the thermionic collector p0732 A80-48477	p0723 A80-48221 Simulation of mass transfer processes in
Thermionic energy conversion. Citations from the BTIS data base	geothermal power cycles with direct contact heat exchange p0724 A80-48222
[PR60-810906] p0747 H80-30953 THERMIOHIC DIODES Progress in the development of small flame heated	Helium-topping/organic bottoming - Advanced power generation system Exergetic/energetic analysis p0673 A80-48247
thermionic energy converters p0732 180-48472 Combustion performance of CVD silicon carbide	Power cycles analyses by generalized thermodynamic properties p0725 A80-48250
thermionic diodes Chemical Vapor Deposition p0732 A80-48473	Analysis of binary thermodynamic cycles for a moderately low-temperature geothermal resource
A computer model of solar panel-plasma interactions [NASA-CE-160796] p0650 M80-32853 THERMIONIC POWER GENERATION	p0725 A80-48267 Eaft Biver 5-MW/e/ geothermal pilot plant p0727 A80-48314
Electric energy production by particle thermionic-thermoelectric power generators p0729 A80-48387	Overview of high efficiency power cycles for fusion p0728 A80-48358 Advanced power technology for fusion reactors
Design study of a coal-fired thermionic /THI/-topped power plant	p0728 A80-48359 Blanket options for high-efficiency fusion power
p0730 A80-48422 Thermionic topping of combined cycle powerplants and cogeneration applications	p0729 180-48360 Comparison of advanced engines for parabolic dish solar thermal power plants
p0730 A80-48423 Progress in the development of small flame heated thermionic energy converters	p0618 A80-48418 Design considerations for a near-term hybrid vehicle p0571 A80-48420
p0732 A80-48472  Combustion performance of CVD silicon carbide thermionic diodes Chemical Vapor Deposition	Thermionic topping of combined cycle powerplants and cogeneration applications p0730 180-48423
p0732 A80-48473 Utilization of low temperature insulators and seals in thermionic converters	Recent progress on the sulfur cycle hybrid hydrogen production process p0663 A80-48460
p0732 A80-48474 Optimal thermionic energy conversion with established electrodes for high-temperature	Assessment of solar thermal concepts for small power systems applications p0618 A80-48463
topping and process heating coal combustion product environments	Power processing and control requirements of dispersed solar thermal electric generation
[HASA-TH-81555] p0754 H80-33221 THERMOCHEMICAL PROPERTIES Present and future status of thermochemical cycles	systems p0619 180-48465 hmmonia/water absorption cycles with relatively
applied to fusion energy sources p0663 A80-48450	high generator temperatures p0625 A80-51682
Basic research needs and priorities in solar energy. Volume 2: Technology crosscuts for DOE [SERI/TE-351-358-VOL-2] p0645 N80-31899	Thermodynamic and economic analysis of heat pumps for energy recovery in industrial processes [ASBE PAPER 78-WA/HT-64] p0686 A80-52049
THERROCHEMISTRY  Materials considerations for the coupling of thermochemical hydrogen cycles to tandem mirror reactors	THERHODYNAMIC REPRICIENCY  Estimated performance of an electrohydrodynamic power generator which utilizes a two-fluid ejector [AIAA PAPER 80-1341] p0717 A80-44126
P0662 A80-48405 Scoping study of a tandem-mirror fusion reactor coupled to a thermochemical hydrogen synfuel plant	Computer simulation of solar pond thermal behavior p0599 180-46567 Thermodynamic analysis of the helium cycles of gas
p0662 180-48406 Hydrogen production from the solar based LASI cadmium cycle	turbine nuclear power plants p0721 A80-47080 On calculating gas turbine efficiency reduction
p0662 A80-48416 High-temperature thermcchemical water splitting cycle fusion reactor design considerations	under the influence of air cooling p0721 A80-47415
p0663 A80-48449 A comparison of capital cost estimates and process	Photocell heat engine solar power systems p0612 A80-48179
efficiencies for hydrogen production by	Circulating timidized had hailer
thermochemical cycles and water electrolysis	Circulating fluidized bed boiler  p0672 A80-48201  Generalized performance predictions for energy
thermochemical cycles and water electrolysis p0663 A80-48458 Process economics and the second law in thermochemical hydrogen production - The effect	p0672 A80-48201 Generalized performance predictions for energy conversion plants using geopressured geothermal fluids p0725 A80-48268
thermochemical cycles and water electrolysis p0663 A80-48458 Process economics and the second law in thermochemical hydrogen production - The effect of heat transfer p0663 A80-48459 Recent progress on the sulfur cycle hybrid	p0672 A80-48201  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids p0725 A80-48268 A thermodynamic analysis of a metal hydride heat pump p0661 A80-48290
thermochemical cycles and water electrolysis p0663 A80-48458  Process economics and the second law in thermochemical hydrogen production - The effect of heat transfer p0663 A80-48459  Recent progress on the sulfur cycle hybrid hydrogen production process p0663 A80-48460 A hybrid water-splitting cycle using copper	p0672 A80-48201  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268  A thermodynamic analysis of a metal hydride heat pump  p0661 A80-48290  Blanket options for high-efficiency fusion power p0729 A80-48360  Analysis and design of free-piston Stirling
thermochemical cycles and water electrolysis p0663 A80-48458  Process economics and the second law in thermochemical hydrogen production - The effect of heat transfer p0663 A80-48459  Recent progress on the sulfur cycle hybrid hydrogen production process p0663 A80-48460 A hybrid water-splitting cycle using copper sulfate and mixed copper oxides  THERMODINAMIC CYCLES	p0672 A80-48201  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268  A thermodynamic analysis of a metal hydride heat pump  p0661 A80-48290  Blanket options for high-efficiency fusion power p0729 A80-48360  Analysis and design of free-piston Stirling engines - Thermodynamics and dynamics  p0729 A80-48407  Harmonic analysis of Stirling engine thermodynamics
thermochemical cycles and water electrolysis p0663 A80-48458  Process economics and the second law in thermochemical hydrogen production - The effect of heat transfer  Recent progress on the sulfur cycle hybrid hydrogen production process  A hybrid water-splitting cycle using copper sulfate and mixed copper oxides  THERMODIMANIC CYCLES Westinghouse OTEC power systems  p0663 A80-48460  p0664 A80-48503	p0672 A80-48201  Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268  A thermodynamic analysis of a metal hydride heat pump  p0661 A80-48290  Blanket options for high-efficiency fusion power p0729 A80-48360  Analysis and design of free-piston Stirling engines - Thermodynamics and dynamics p0729 A80-48407  Harmonic analysis of Stirling engine thermodynamics p0730 A80-48408  Performance loss due to transient heat transfer in
thermochemical cycles and water electrolysis p0663 A80-48458  Process economics and the second law in thermochemical hydrogen production - The effect of heat transfer  p0663 A80-48459  Recent progress on the sulfur cycle hybrid hydrogen production process  p0663 A80-48460  A hybrid water-splitting cycle using copper sulfate and mixed copper oxides  THERMODIMATIC CYCLES Westinghouse OTEC power systems	p0672 A80-48201 Generalized performance predictions for energy conversion plants using geopressured geothermal fluids  p0725 A80-48268 A thermodynamic analysis of a metal hydride heat pump  p0661 A80-48290 Blanket options for high-efficiency fusion power p0729 A80-48360 Analysis and design of free-piston Stirling engines - Thermodynamics and dynamics p0729 A80-48407 Harmonic analysis of Stirling engine thermodynamics p0730 A80-48408

SUBJECT INDEX THIS PILES

Process economics and the second law in . Estimating capacity of solar thermoelectric thermochemical hydrogen production - The effect generator /STEG/ panels of heat transfer p0610 A80-47155 p0663 A80~48459 RTG power source for the International Solar Polar An advanced 15 kW solar powered free-piston p0727 A80-48305 Stirling engine P0619 A80-48467 Electric energy production by particle thermionic-thermoelectric power generators Simulation and evaluation of latent heat thermal energy storage heat pump systems p0729 A80-48387 Analysis of the application of thermogalyanic cells to the conversion of low grade heat to p0771 A80~48478 Chemical fuel and raw material production by thermal processing of refuse - Technology and electricity p0729 A80-48390 Comparative economics of small solar thermal p0684 A80-50010 On the selection of working fluids for OTEC power electric power systems plants p0618 A80-48462 P0738 A80-50946 Assessment of solar thermal concepts for small power systems applications The solution to the gas turbine temperature problem --- engine design p0618 A80-48463 p0738 A80-50949 THERMOBLECTRIC MATRELALS Transient thermal behaviour of solar ponds Demonstration of heat to electrical energy p0623 A80-50962 conversion with a ferroelectric material Second law and radiation p0729 A80-48386 Thermoelectric properties of bismuth-antimony thin p0738 A80-51203 Thermodynamic analysis of coal gasification films --- for energy conversion p0729 A80-48391
Thermoelectricity - Phase diagrams and imperfection structure processes p0686 A80-51210 A thermal performance evaluation technique for p0731 A80-48434 Universal thermoelectric design curves --- of heat passive space heating systems . p0626 A80-52827 Steam engine analysis Dumps p0743 N80-29741 [FE-8917-2] p0731 A80-48435 Thermoelectric OTEC - An update --design analysis p0731 A80-48436 Coal gasification pilot plant support studies [FB-2806-5] p0704 880-31637 Hydrogen production by the GA sulfur-iodine process [GA-A-15777-REV] p0666 N80-31651 THERMOELECTRIC POWER GRNERATION Design of a thermophotocell Analytical prediction of liquid p0610 A80-47154 BTG power source for the International Solar Polar photovoltaic/thermal flat-plate collector performance COO-4094-66] p0727 A80-48305 p0646 N80-31913 Thermoelectric OTEC - An update --- design analysis p0731 A80-48436 Pulse combustion technology for heating applications
[ANL/EES/TH-85] p0707 B80-32467 [ANL/EES/TH-85] p0707 N80-Reduction of fuel consumption by thermodynamic Thermelectric materials for solar energy conversion optimization of the Otto motor: Comparative investigation of Otto diesel engines [EUR-6711-DE] p0585 N80 [AD-A084948] . p0631 N80-28869 p0585 N80-32733 Thermoelectric MHD with walls parallel to the Analytical prediction of the performance of an air magnetic field photovoltaic/thermal flat plate collector [DOE/ET-20279/93] p0653 p0739 A80-52971 p0653 N80-32914 THERMOHYDRAULICS Coal gasification combined-cycle system analysis The mist-lift OTEC cycle [EPRI-AP-1390]
THERMODYNAMIC EQUILIBRIUM p0713 N80-33601 D0718 A80-44602 THERMONUCLEAR REACTIONS Hydrogen distribution and transfer in coal hydrogenation systems Pusion reactors for hydrogen production via electrolysis [DOE/PC-30014/1] p0758 ¥80-29473 [BNL-27782] p0667 N80-32559 THER HODY BABIC PROPERTIES TRICK PILES Overview of thick-film technology as applied to Power cycles analyses by generalized thermodynamic properties solar cells [ SERI/TP-331-541] p0725 A80-48250 p0639 N80-29895 THICKEBERS (MATERIALS)

An investigation of the thermal energy storage capacity of Glauber's salt with respect to Temperature limitations of alkaline battery electrodes p0766 A80-48330 Analysis of a heat-activated Stirling heat pump p0730 A80-48424 The thermodynamics of aqueous water electrolysis thermal cycling p0774 A80-51683 p0664 A80-50511 Thin film /CdZn/S for solar cells p0603 A80-46727 Progress in the development of the thin film BIS THERMODYNAMICS Second law analysis of energy devices and processes; Proceedings of the Workshop, George Washington University, Washington, D.C., August solar cell based on CdSe p0603 A80-46728 14-16, 1979 An S.E.M. study of thin films made by spray pyrolysis --- CdS deposition on solar p0576 A80-51202 photovoltaic panels Heat pipes. Citations from the Engineering Index data base p0781 N80-28682 Survey of semiconductor combinations for optimum beterojunction thin film solar cells [ PB80-809965 1 Citations from the engineering index Heat pipes. data base p0605 A80-46753 Integrated Cu2S-CdS thin film solar cell generator p0606 A80-46770 [PB80-809973] p0781 N80-28683 Relevance of the second law of thermodynamics to Photon loss analysis and design of thin-film energy conservation
[DOE/CS-40178/01-VOL-1] planar junction Cu2S/CdS devices p0590 N80-33288 THER MOBLECTRIC GENERATORS p0607 A80-46776 Matching of a radioisotopic thermoelectric Optical and calorimetric measurements of curreous sulphides thin films --- for solar cells generator and an energy accumulator p0720 A80-46599 p0607 A80-46779 Metallic thermoelectric materials in solar Preparation and analysis of Cu20 thin-film solar thermoelectric generators cells p0607 A80-46781 D0610 A80-47152

THREE DIMENSIONAL PLOW SUBJECT INDEX

•			
Thermoelectric properties of bismuth-an	timony thin	Linear analysis of the double-tearing	mode in
films for energy conversion p0	729 A80-48391	tokamak discharges P	0718 A80-44390
Thin film solar cells  p0 Optimized grid patterns for Cu2S-CdS so	619 A80-48513	Neutral-beam energy and power requirem expanding-radius and full-bore start tokamak reactors	
р0	621 A80-49322	P	0719 180-44656
Thin film cuprous sulphide-cadmium sulp cells	hide solar	Particle confinement scaling experimen Culham Levitron	ts in the
	628 A80-52862		0719 A80-44657
Coplanar back contacts for thin silicon	solar cells	Combined n equal to 0 and n not equal	
[NASA-CR-159811] p0	630 NEO-28860	stability analysis of axisymmetric s	
Reactively sputtered thin film cu/sub x	/s/cds.	current model equilibria	
photovoltaic devices		p	0719 A80-44659
	637 N80-29875	Absolute dissipative drift-wave instab	ilities in
Development of a cadmium selenide thin	film solar	tokamaks	
cell			0719 480-44663
	640 N80-29907	Transport code simulations of lower by	brid heating
Thin films of InP for photovoltaic ener		in tokamaks	0340 100 111661
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Controlled cadmium telluride thin films		CT-6 tokamak research. II - Experiment	
cell applications (emerging materials	systems		0721 180-46670
for solar cell applications) [DOE/ET-23023/T3] p0	642 N80-30921	<pre>Porm factor for certain types of toroi in tokamak fusion devices</pre>	dar somenords
Low cost solar cells based on amorphous			0721 A80-47230
electrodeposited from organic solvent		Perspective on the DOE fusion syntheti	
	648 N80-31953	program	C IGCID .
CdSias2 thin films for solar cell appli			0677 A80-48402
	653 N80-32919	HYFIRE - Fusion-high temperature elect	
Amorphous thin films for sclar-cell app			0731 A80-48448
[DOE/ET-21074/4] p0	653 N80-32921	Energy conversion considerations of the	e STAEFIRE
Electrochemical photovoltaic cells cdSe	thin film .	commercial fusion power plant	
electrodes		P	0733 A80-48490
	654 N80-32925	Experimental evidence of charge-exchan	
HREE DIMENSIONAL PLON		recombination of highly ionized iron	and
WIND: Computer program for calculation		titanium in Princeton large torus	
dimensional potential compressible fl	ow about		0735 A80-48765
wind turbine rotor blades	265 NOV 22352	Alteration of Pfirsch-Schlueter transp	
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IDEPOWER	701 200 31320	Bifurcation of sharp boundary beta=1 m	
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. p0	688 A80-53680 . assessment		0736 A80-49074
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pO Tidal energy and the energy crisis - An of technology and the interrelationsh	assessment	Observations of fluctuating omega sub in Alcator tokamaks	0736 A80-49074
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Tidal energy and the energy crisis - An of technology and the interrelationsh of technology and the interrelationsh po Patent profiles: Solar energy [PB80-190010] po Patent profiles: Solar energy [PB80-196041] po PDE PERMISSION [PB80-196041] po PDE PERMISSION [PB80-196041] po PDE PERMISSION [PB80-196041] po PDE PERMISSION [PAPEN 79-G7/ISR-2] po PDE PAPEN	assessment ir 689 A80-53682 649 N80-31966  714 N80-34052 ine with 720 A80-45663 or an est 709 N80-32565 de/silicon 622 A80-50752 e 685 A80-50036 e and 735 A80-48765	Observations of fluctuating omega sub in Alcator tokamaks  Destabilization of drift-universal eig toroidal effects  Density profiles in tokamaks from elec cyclotron radiation spectra  Some perspectives on the use of powerf for the electron-cyclotron plasma he large tokamaks  Conceptual design of EST: An rf-drive steady-state Tokamak [EFRI-AP-1351] Tokamak poloidal field systems [LA-8375-PR]  DUBBE  The hydropyrolysis of coal to BTX Toluene and Tylenes  OLS  Comparative study of the energy charac powered hand tools. Part 2: Invest reports [SAN-1731-T2]  POGGRAPHY Sites for wind-power installations: P	0736 A80-49074 p emission 0736 A80-49075 enmodes by 0736 A80-49209 tron 0738 A80-51018 ul gyrotrons ating in 0738 A80-51038 n, 0751 N80-32233 0754 N80-32233 Benzene, 0688 A80-53174 teristics of igation 0577 N80-28856 hysical ridges and
Tidal energy and the energy crisis - An of technology and the interrelationsh of technology and the interrelationsh potential profiles: Solar energy [PB80-190010] potential program [PB80-196041] potential program [PB80-196	assessment ir 689 A80-53682 649 N80-31966  714 N80-34052 ine with 720 A80-45663 or an est 709 N80-32565 de/silicon 622 A80-50752 e 685 A80-50036 e and 735 A80-48765 2 cells 773 A80-50508	Observations of fluctuating omega sub in Alcator tokamaks  Destabilization of drift-universal eig toroidal effects  Density profiles in tokamaks from elec cyclotron radiation spectra  Some perspectives on the use of powerf for the electron-cyclotron plasma he large tokamaks  Conceptual design of EST: An rf-drive steady-state Tokamak [EFRI-AP-1351] Tokamak poloidal field systems [LA-8375-PR]  DUBBE  The hydropyrolysis of coal to BTX Toluene and Kylenes  OLS  Comparative study of the energy charac powered hand tools. Part 2: Invest reports [SAN-1731-T2]  POGGRAPHY Sites for wind-power installations: Progeness of the influence of hills, complex terrain on wind speed and tupart 1: Executive summary	0736 A80-49074 p emission 0736 A80-49075 enmodes by 0736 A80-49209 tron 0738 A80-51018 ul gyrotrons ating in 0738 A80-51038 n, 0751 N80-32233 0754 N80-32233 Benzene, 0688 A80-53174 teristics of igation 0577 N80-28856 hysical ridges and
Tidal energy and the energy crisis - An of technology and the interrelationsh pofetenhology and the interrelationsh power [PB80-190010] power [PB80-190010] power [PB80-196041] power [PB8	assessment ir 689 A80-53682 649 N80-31966  714 N80-34052 ine with 720 A80-45663 or an est 709 N80-32565 de/silicon 622 A80-50752 e 685 A80-50036 e and 735 A80-48765 2 cells 773 A80-50508 ne TiO2	Observations of fluctuating omega sub in Alcator tokamaks  Postabilization of drift-universal eig toroidal effects  Density profiles in tokamaks from elec cyclotron radiation spectra  Some perspectives on the use of powerf for the electron-cyclotron plasma he large tokamaks  Conceptual design of EST: An rf-drive steady-state Tokamak [EFRI-AP-1351] Tokamak poloidal field systems [LA-8375-PR] plubbe The hydropyrolysis of coal to BTX Toluene and Tylenes  OLS  Comparative study of the energy charac powered hand tools. Part 2: Invest LEPOTTS [SAN-1731-T2]  POGRAPHY  Sites for wind-power installations: P modeling of the influence of hills, complex terrain on wind speed and tu Part 1: Executive summary [BLO-2438-78/1]  DEGIDAL PLASMAS	0736 A80-49074 p emission 0736 A80-49075 enmodes by 0736 A80-49209 tron 0738 A80-51018 ul gyrotrons ating in 0738 A80-51038 n, 0751 N80-32233 0754 N80-33233 Benzene, 0688 A80-53174 teristics of igation 0577 N80-20856 hysical ridges and rbulence. 0706 N80-31900
Tidal energy and the energy crisis - An of technology and the interrelationsh of technology and the interrelationsh posterior profiles: Solar energy [PB80-190010] posterior profiles: The SWAB (Spectral Wave And Bar) progration [PB80-196041] posterior profiles and progration profiles profile	assessment ir 689 A80-53682 649 N80-31966  714 N80-34052 ine with 720 A80-45663 or an est 709 N80-32565 de/silicon 622 A80-50752 e 685 A80-50036 e and 735 A80-48765 2 cells 773 A80-50508 ne TiO2 rsion	Observations of fluctuating omega sub in Alcator tokamaks  Destabilization of drift-universal eig toroidal effects  Density profiles in tokamaks from elec cyclotron radiation spectra  Some perspectives on the use of powerf for the electron-cyclotron plasma he large tokamaks  Conceptual design of EST: An rf-drive steady-state Tokamak [EFRI-AP-1351] pt Tokamak poloidal field systems [LA-8375-PR] pt LURBE The hydropyrolysis of coal to BTI Toluene and Tylenes  OLS  Comparative study of the energy charac powered hand tools. Part 2: Invest reports [SAN-1731-T2]  POGRAPHY  Sites for wind-power installations: Pr modeling of the influence of hills, complex terrain on wind speed and tu Part 1: Executive summary [BLO-2438-78/1]	0736 A80-49074 p emission 0736 A80-49075 enmodes by 0736 A80-49209 tron 0738 A80-51018 ul gyrotrons ating in 0738 A80-51038 n, 0751 N80-32233 0754 N80-33233 Benzene, 0688 A80-53174 teristics of igation 0577 N80-20856 hysical ridges and rbulence. 0706 N80-31900
Tidal energy and the energy crisis - An of technology and the interrelationsh of technology and the interrelationsh potential profiles: Solar energy [PB80-190010] potential pot	assessment ir 689 A80-53682 649 N80-31966  714 N80-34052 ine with 720 A80-45663 or an est 709 N80-32565 de/silicon 622 A80-50752 e 685 A80-50036 e and 735 A80-48765 2 cells 773 A80-50508 ne TiO2	Observations of fluctuating omega sub in Alcator tokamaks  Destabilization of drift-universal eig toroidal effects  Density profiles in tokamaks from elec cyclotron radiation spectra  Some perspectives on the use of powerf for the electron-cyclotron plasma he large tokamaks  Conceptual design of EST: An rf-drive steady-state Tokamak [EFRI-AP-1351] pt Tokamak poloidal field systems [LA-8375-PE] pt LUEBE The hydropyrolysis of coal to BTI Toluene and Tylenes  POLS  Comparative study of the energy charac powered hand tools. Part 2: Invest reports [SAN-1731-T2]  POGRAPHY Sites for wind-power installations: Pr modeling of the influence of hills, complex terrain on wind speed and tu Part 1: Executive summary [BLO-2438-78/1] pt BOIDAL PLASMAS  Energy principle with global invariant	0736 A80-49074 p emission 0736 A80-49075 enmodes by 0736 A80-49209 tron 0738 A80-51018 ul gyrotrons ating in 0751 N80-32233 0754 N80-33233 Benzene, 0688 A80-53174 teristics of igation 0577 N80-20856 hysical ridges and rbulence. 0706 N80-31900 s for
Tidal energy and the energy crisis - An of technology and the interrelationsh of technology and the interrelationsh po Patent profiles: Solar energy [PB80-190010] po PEDES  The SWAB (Spectral Wave And Bar) progra [PB80-196041] po PEDES  The DEPENDENCE  The Dependence of a closed-cycle gas turb time dependent operating conditions [ASME PAPER 79-GI/ISR-2] po PILIGHT SPECTEOHETRES  Use of an automated mass spectrometer f underground coal gasification field t [UCEL-84366] po PEDES Short circuit current in indium tin ori solar cells  FIRES  Fuel gas from used tyres by means of the Babcock-Rohrbach process  FIRHIUM  Experimental evidence of charge-exchang recombination of highly icnized iron titanium in Frinceton large torus  ETABLUM COMPOUEDS  Evaluation of high temperature LiAl/Tis po Po Polycrystalli electrodes for solar energy conveptors  EVALUAR DEVICES	assessment ir 689 A80-53682 649 N80-31966  714 N80-34052 ine with 720 A80-45663 or an est 709 N80-32565 de/silicon 622 A80-50752 e 685 A80-50036 e and 735 A80-48765 2 cells 773 A80-50508 ne TiO2 rsion 664 A80-51691	Observations of fluctuating omega sub in Alcator tokamaks  Destabilization of drift-universal eig toroidal effects  Density profiles in tokamaks from elec cyclotron radiation spectra  Some perspectives on the use of powerf for the electron-cyclotron plasma he large tokamaks  Conceptual design of EST: An rf-drive steady-state Tokamak [EFRI-AP-1351] Tokamak poloidal field systems [LA-8375-PR] plubbe The hydropyrolysis of coal to BTX Toluene and Tylenes  OLS  Comparative study of the energy charac powered hand tools. Part 2: Invest LEPOTTS [SAN-1731-T2]  POGRAPHY  Sites for wind-power installations: P modeling of the influence of hills, complex terrain on wind speed and tu Part 1: Executive summary [BLO-2438-78/1]  DEOIDAL PLASMAS  Energy principle with global invariant toroidal plasmas	0736 A80-49074 p emission 0736 A80-49075 enmodes by 0736 A80-49209 tron 0738 A80-51018 ul gyrotrons ating in 0738 A80-51038 n, 0751 N80-32233 0754 N80-32233 Benzene, 0688 A80-53174 teristics of igation 0577 N80-28856 hysical ridges and rbulence. 0706 N80-31900 s for
Tidal energy and the energy crisis - An of technology and the interrelationsh potential profiles: Solar energy [PB80-190010] potent profiles: Solar energy [PB80-190010] potential profiles: The SWAB (Spectral Wave And Bar) progration of the Deprendence of a closed-cycle gas turb time dependent operating conditions [ASME PAPER 79-G7/ISR-2] potential profiles of an automated mass spectrometer funderground coal gasification field to [UCB1-84366] potential profiles short circuit current in indium tin ori solar cells potential profiles potential profiles profiles from used tyres by means of the Babcock-Rohrbach process potential profiles potential profiles profiles potential profiles	assessment ir 689 A80-53682 649 N80-31966  714 N80-34052 ine with 720 A80-45663 or an est 709 N80-32565 de/silicon 622 A80-50752 e 685 A80-50036 e and 735 A80-48765 2 cells 773 A80-50508 ne TiO2 rsion 664 A80-51691	Observations of fluctuating omega sub in Alcator tokamaks  Destabilization of drift-universal eig toroidal effects  Density profiles in tokamaks from elec cyclotron radiation spectra  Some perspectives on the use of powerf for the electron-cyclotron plasma he large tokamaks  Conceptual design of EST: An rf-drive steady-state Tokamak [EFRI-AP-1351] Tokamak poloidal field systems [LA-8375-PR]  DUBBE The hydropyrolysis of coal to BTX Toluene and Kylenes  OLS  Comparative study of the energy charac powered hand tools. Part 2: Invest reports [SAN-1731-T2]  POGGRAPHY Sites for wind-power installations: P modeling of the influence of hills, complex terrain on wind speed and tu Part 1: Executive summary [BLO-2438-78/1]  ELO-2438-78/1]  ELO-2438-78/1]  ELO-2438-78/1]  ELO-2438-78/1]  ELO-2438-78/1]  ELO-2438-78/1]  ELO-2438-78/1]  ELO-2438-78/1]  FOR CT-6 tokamak research - Development and	0736 A80-49074 p emission 0736 A80-49075 enmodes by 0736 A80-49209 tron 0738 A80-51018 ulgyrotrons ating in 0738 A80-51038 n, 0751 N80-32233 0754 B80-33233 Benzene, 0688 A80-53174 teristics of igation 0577 N80-28856 hysical ridges and rbulence. 0706 N80-31900 s for
Tidal energy and the energy crisis - An of technology and the interrelationsh of technology and the interrelationsh po Patent profiles: Solar energy [PB80-190010] po PB80-190010] po PB80-196041] po PB80-196	assessment ir 689 A80-53682 649 N80-31966  714 N80-34052 ine with 720 A80-45663 or an est 709 N80-32565 de/silicon 622 A80-50752 e 685 A80-50036 e and 735 A80-48765 2 cells 773 A80-50508 ne TiO2 rsion 664 A80-51691	Observations of fluctuating omega sub in Alcator tokamaks  Destabilization of drift-universal eig toroidal effects  Density profiles in tokamaks from elec cyclotron radiation spectra  Some perspectives on the use of powerf for the electron-cyclotron plasma he large tokamaks  Conceptual design of EST: An rf-drive steady-state Tokamak [EFRI-AP-1351] pt Tokamak poloidal field systems [LA-8375-PE] pt LUEBE The hydropyrolysis of coal to BTX Toluene and Tylenes  OLS  Comparative study of the energy charac powered hand tools. Part 2: Invest reports [SAN-1731-T2]  POGRAPHY Sites for wind-power installations: Pr modeling of the influence of hills, complex terrain on wind speed and tu Part 1: Executive summary [BLO-2438-78/1] pt HOGINAL PLASMAS  Energy principle with global invariant toroidal plasmas  CT-6 tokamak research - Development an operation of the experimental device	0736 A80-49074 p emission 0736 A80-49075 enmodes by 0736 A80-49209 tron 0738 A80-51018 ulgyrotrons ating in 0738 A80-51038 n, 0751 N80-32233 0754 B80-33233 Benzene, 0688 A80-53174 teristics of igation 0577 N80-28856 hysical ridges and rbulence. 0706 N80-31900 s for

SUBJECT INDEX TRANSPORTATION EMERGY

•	
Linear analysis of the double-tearing mode in tokamak discharges	TRANSMITTERS National solar optical materials program plan: An
p07 18 A8Q-44390	overview
Neutral-beam energy and power requirements for expanding-radius and full-bore start-up of	[SERI/TP-641-619] p0639 N80-29892 TRANSPORT AIRCRAFT
tokamak reactors	Prospects for hydrogen aircraft
p0719 A80-44656 Absolute dissipative drift-wave instabilities in	[SAE FAFEE 800756] p0664 A80-49704 Study of methane fuel for subsonic transport
tokamaks p0719 A80-44663	aircraft [NASA-CB-159320] p0708 N80-32533
CI-6 tokamak research. II - Experimental results p0721 A80-46670	TRANSPORT PROPERTIES  Transport code simulations of lower hybrid heating
HYFIRE - Fusion-high temperature electrolysis system	in tokamaks
p0731 A80-48448 Destabilization of drift-universal eigenmodes by	TRANSPORT THROBY
toroidal effects p0736 A80-49209	Alteration of Pfirsch-Schlueter transport in tokamaks by all four external sources
TOROIDS	p0735 A80-49058
Toroidal cell and battery energy storage for	TRANSPORT VEHICLES
orbital space applications or power cells for electric vehicles	Puel cell systems for vehicular applications [SAE PAPER 800059] p0736 A80-49720
[NASA-CASE-LEW-12918-1] p0780 N80-33857	TRANSPORTATION
TRACE CONTANIBANTS Some etching studies of the microstructure and	Worldwide transportation/energy demand, 1975-2000:  Bevised Variflex Model projections
composition of large aluminosilicate particles	[ORNL/SUB-79/45740/1] p0578 N80-28915
in fly ash from coal-burning power plants	TRANSPORTATION ENERGY
p0569 A80-45481	The case for fuel-cell-powered vehicles
TRACE ELEMENTS  The long-term effects of trace elements emitted by	p0721 A80-47100 Blectric Vehicles - Finally a reality
energy conversion of lignite coal	p0762 A80-48125
[PB80-168867] p0578 N80-28958	Adapting geothermal energy to produce ethanol for
The long-term effects of trace elements emitted by	automotive fuel
energy conversion of lignite coal. Volume 2:	p0723 A80-48183
Technical appendices [PB80-168875] p0579 N80-28960	Recent progress in lithium/iron sulfide battery development
TRACKING (POSITION)	p0762 180-48188
Synthesis of four bar linkages for solar tracking	Optimization studies of lithium/iron sulfide cells
p0624 A80-51677	for electric vehicle applications
Development of a second generation concentrating tracking solar collector	p0763 A80-48190 Development of a tubular lithium-iron sulfide cell
[ASE-4524] p0636 N80-29871	p0763 A80-48192
TRACES	Scaling up of bipolar lithium/iron disulfide cells
Wind energy capacity of a single airfoil with	p0763 A80-48193
vertical axis on a circular track	Wind energy for electric vehicle recharge p0726 180-48273
TRADROPPS	Improved alkaline hydrogen/air fuel cells for
Trade-off results and preliminary designs of	transportation applications
Near-Term Hybrid Vehicles [SAE PAPER 800064] p0772 A80-49723	p0726 A80-48282 Development of a bipolar Zn/Br2 battery
TRANSPER PUNCTIONS	p0767 A80-48369
Transfer function of a sensible-heat storage	Performance and structural characteristics of the
element in periodic regime	iron-air battery system for electric vehicle
TRANSPERRING p0774 A80-52974	propulsion p0767 A80-48371
Investigation of mechanisms of hydrogen transfer	Development of a lithium-water-air primary battery
in coal hydrogenation, phase 2	for automotive propulsion
[FE-2305-30] p0710 N80-32568	p0768 A80-48372
TRANSIENT BESPONSE  Transient response of a latent heat storage unit -	The aluminum-air battery for electric vehicle propulsion
An analytical and experimental investigation	p0768 A80-48373
[ASHE PAPER 79-HT-36] p0761 A80-45726	The new age of high performance kinetic energy
Performance loss due to transient heat transfer in the cylinders of Stirling engines	storage systems p0768 A80~48374
p0730 A60-48410	Flywheel-transmission characteristics required for
Transient behaviour of wind energy systems	break-even impact on automotive vehicle
p0734 A80-48521	performance
TRANSITION METALS Materials for fuel cells	p0768 A80-48378 Fuel cell systems for vehicular applications
[PB80-182355] p0748 N80-30955	[SAE PAPER 800059] p0736 A80-49720
TRANSMISSION RPFICIENCY	Impact of electric cars on national energy
Plywheel-transmission characteristics required for	consumption
break-even impact on automotive vehicle performance	[SAE PAPER 800111] p0573 A80~49728 Analysis of the infrastructure for recharging
p0768 A80-48378	electric vehicles
Small passenger car transmission test; Chevrolet	[SAE PAPER 800112] p0773 A80~49729
LUV transmission	Development research program for clean industrial
[NASA-CR-159882] p0584 N80-31796	and transportation fuels from coal [PE-2514-31] p0691 N80-28554
TRABSMISSIONS (MACHINE BLEMBETS)  An automotive transmission for automotive gas	The potential of energy farming for transport
turbine power plants	fuels in New Zealand, appendices
[SAE PAPER 800099] p0736 A80-49724	[PB80-154255] p0693 N80-28573
Small passenger car transmission test; Chevrolet LUV transmission	Interactions between energy supply and transportation-related energy use, volume 1
[NASA-CR-159882] p0584 N80-31796	[PB80-185002]
Design study of steel V-Belt CVT for electric	California's biomass and its energy potential
vehicles	[LBL-10058] p0709 N80-32564
[NASA-CR-159845] p0777 N80-32299	£

TROUBE WALLS SUBJECT INDEX

TROBBE WALLS	Advanced synfuels production/power systems
Performance of storage walls with highly	utilizing laser particulate control
conductive covering plates and connecting fins	[BNI-27783] p0710 880-3257
[ASME PAPER 80-HI-18] p0762 A80-48009	UTRC 8 kW wind turbine tests [RPP-3085] p0752 N80-3272
Trombe wall ws direct gain - A comparative analysis of passive solar heating systems	TURBOPAN REGINES
p0626 A80-52828	Improved components for engine fuel savings
The effect of design parameter changes on the	[NASA-TM-81577] p0583 N80-3140
performance of thermal storage wall passive	The energy efficient engine project
systems	[NASA-TM-81566] p0585 N80-3239
p0626 180-52829	TURBOGENERATORS
Experimental investigation of the Trombe wall passive solar energy system	A 150 MW power generating gas turbine plant p0719 A80-4477
p0627 A80-52833	Development of a 4 kW wind turbine generator
TRUCKS	p0725 A80-4826
Potential of diesel engine, 1979 summary source	Implications of the effects of wind
document	characteristics on the operation of large wind
[PB80-193659] p0585 880-32734	turbines
TUBE HEAT EXCHANGEES	p0727 A80-4832 The MOD-2 wind turbine
Thermal stress in a composite cylinder by finite difference technique solar concentrator	p0727 A80-4832
tubular heat exchanger	Solar thermal electric power systems in Japan
[ASMB PAPER 80-HT-107] p0612 A80-48036	p0620 A80-4891
A thermodynamic analysis of a metal hydride heat	<ul> <li>Bavy-New Hampshire wind energy program</li> </ul>
pump - occa and money	[AD-A086506] p0701 N80-3090
p0661 A80-48290 TUNGSTEN COMPOUNDS	Energy analysis of geothermal-electric systems
Photoelectrochemical compatibility of n-WSe2 and	[COO-5085-4] p0584 B80-3191 Summary of guidelines for siting wind turbine
n-MoSe2 with various redox systems	denerators relative to small-scale.
photodecomposition of semiconductor solar cell	two-dimensional terrain features
surface	[BLO-2443-77/1] p0647 H80-3193
p0610 A80-47141	Large wind turbine generator performance assessment
TORBINE BLADES	[EPRI-AP-1317] p0751 N80-3196
Low cost composite materials for wind energy conversion systems	Bigh-temperature turbine technology program. Overall plant Design Description (OPDD)
p0717 A80-44104	coal-derived liquid
Combined effects of periodic and stochastic loads	[FE-1806-84] p0712 880-3272
on the fatigue of wind turbine parts, part 6	High-temperature turbine technology program.
[PPA-AU-1499-PT-6] p0741 N80-28732	Overall Plant Design Description (OFDD) low-Btu
Large wind turbine generator performance assessment	coal gas electric power plant
[EPEI-AP-1317] p0751 N80-31960 Advanced synfuels production/power systems	[FE-1806-83] p0752 N80-3272
utilizing laser particulate control	Large wind turbines: A utility option for the generation of electricity
[BHL-27783] p0710 M80-32570	[NASA-TH-81502] p0752 N80-3285
WIND: Computer program for calculation of three	District heating and cooling systems for
dimensional potential compressible flow about	communities through power plant retrofit
dimensional potential compressible flow about wind turbine rotor blades	communities through power plant retrofit distribution network, volume 4
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 #80-3294
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357 TURBINE ENGINES	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 #80-3294: ####################################
dimensional rotential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357 TURBINE ENGINES Power production from geothermal brine with the	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294; MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386.
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357 TURBINE ENGINES	communities through power plant retrofit distribution network, volume 4 .[coo-4977/1-v0L-4] p0753 #80-3294: ####################################
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357 TURBINE ENGINES Power production from geothermal brine with the rotary separator turbine p0725 N80-48266 Mechanisms of nitrogen heterocycle influence on	communities through power plant retrofit distribution network, volume 4 .[c00-4977/1-V0L-4] p0753 880-3294. MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386 TURBOHALHERN Pield experiences with rotordynamic instability in high-performance turbomachinery oil and
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 N80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386 TURBONACHIBENY Pield experiences with rotordynamic instability in high-performance turbonachinery oil and natural gas recovery
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES Power production from geothermal brine with the rotary separator turbine p0725 A80-48266 Hechanisms of nitrogen heterocycle influence on turbine fuel stability p0695 E80-29327	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386  TURBORACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  p0697 N80-2970
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357 TORBINE ENGINES Power production from geothermal brine with the rotary separator turbine p0725 A80-48266 Mechanisms of nitrogen heterocycle influence on turbine fuel stability p0695 N80-29327 Aviation turbine fuels, 1979	COMMUNITIES through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386 TURBOHACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  TURBULERT WARES
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386 TURBORACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  TURBULENT WARES Wake decay and power reduction in wind farm arrays
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357 TORBINE ENGINES Power production from geothermal brine with the rotary separator turbine p0725 A80-48266 Mechanisms of nitrogen heterocycle influence on turbine fuel stability p0695 N80-29327 Aviation turbine fuels, 1979	COMMUNITIES through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386 TURBOHACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  TURBULERT WARES
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  P0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate for	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294. MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386. TUBBOMACHIBENT Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES Power production from geothermal brine with the rotary separator turbine p0725 A80-48266 Hechanisms of nitrogen heterocycle influence on turbine fuel stability p0695 E80-29327 Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUBPS Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386 TURBOHACHIBENT Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 880-2970 TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability p0695 E80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage p0768 A80-48375	communities through power plant retrofit distribution network, volume 4 [CCO-4977/1-V0L-4] p0753 880-3294: MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386: TURBORACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  p0697 880-2970: TURBULEBY WARES Wate decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills  p0735 A80-4852. THO STAGE TURBINES Design study of a two-phase turbine bottoming cycle
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294.  MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386.  TURBOMACHIBENT  Field experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills  P0735 A80-4852.
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES Power production from geothermal brine with the rotary separator turbine p0725 A80-48266 Hechanisms of nitrogen heterocycle influence on turbine fuel stability p0695 E80-29327 Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUBPS Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage p0768 A80-48375  TURBINE WHERLS Turbulence as experienced by a moving rotor of a	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386 TUBBOMACHIBENT Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 880-2970 TUBBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852 TWO STAGE TUBBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 880-3075
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 E80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS Turbulence as experienced by a moving rotor of a wind turbine	communities through power plant retrofit distribution network, volume 4 [CCO-4977/1-V0L-4] p0753 880-3294: MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386: TURBORACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  p0697 880-2970: TURBULEBY WARES Wate decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills  p0735 A80-4852. THO STAGE TURBINES Design study of a two-phase turbine bottoming cycle
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Hechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 H80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386 TUBBOMACHIBENT Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 880-2970 TUBBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852 TWO STAGE TUBBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 880-3075
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES Power production from geothermal brine with the rotary separator turbine  Bechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 E80-29327 Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TURBINES Comparison with strain gage data of centrifugal	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294. MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386.  TUBBOMACHIBENT Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 N80-2970  TUBBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852.  THO STAGE TUBBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 N80-3075  U ULTRASOBICS Ultrasonic characterization of coal liquefaction
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294  MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386  TURBOBACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 880-2970  TURBULERT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852  TWO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1]  ULTRASOBICS Ultrasonic characterization of coal liquefaction products
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Hechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 H80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  p0768 A80-48375  TURBINE HHEELS Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TURBINES Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294.  MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386.  TURBOMACHIBENT  Field experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 880-2970.  TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills  p0735 A80-4852.  TWO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 880-3075.  U  ULTRASOBICS Ultrasonic characterization of coal liquefaction products [DOE/C-10346/1] p0702 880-3150.
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability p0695 E80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage p0768 A80-48375  TURBINE WHEELS Turbulence as experienced by a moving rotor of a wind turbine p0727 A80-48320  TURBINES Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 Darrieus turbine [SAND-79-1990] p0741 E80-28756	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294. MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386.  TURBORACHIBRY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 N80-2970  TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852.  THO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 N80-3075  U  ULTRASONICS Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-3150. UNDERGEROURD STRUCTURES
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES Power production from geothermal brine with the rotary separator turbine p0725 A80-48266 Hechanisms of nitrogen heterocycle influence on turbine fuel stability p0695 H80-29327 Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage p0768 A80-48375  TURBINE WHEELS Turbulence as experienced by a moving rotor of a wind turbine p0727 A80-48320  TURBINES Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386  TURBOBACHISENY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 N80-2970  TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852  TWO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] ULTRASONICS Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] UBDERGROUND STBUCTURES Highlights of the LLL Hoe Creek No. 3 underground
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294. MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386.  TURBORACHIBRY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 N80-2970  TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852.  THO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 N80-3075  U  ULTRASONICS Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-3150. UNDERGEROURD STRUCTURES
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729]  FORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  PO725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  PO695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2]  FURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  PO768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  PO727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990]  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2]  Review of the current status of the wind energy	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294  MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386  TURBOMACHIBERY  Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 N80-2970  TURBULEHT WARES  Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852  TWO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1]  ULTRASOBICS Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] UBDERGROUND STBUCTURES Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  P0670 A80-46600 Results from the Hoe Creek No. 3 underground coal
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen beterocycle influence on turbine fuel stability  p0695 E80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TORBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TORBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888  Review of the current status of the wind energy innovative systems projects	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294.  MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386.  TURBOMACHIBENT  Field experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 880-2970.  TURBULENT WARES  Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills  p0735 A80-4852.  TWO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 880-3075.  U  ULTRASOBICS  Ultrasonic characterization of coal liquefaction products [DOE/FC-10346/1] p0702 880-3150.  UBDERGEOUND STRUCTURES Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  P0670 A80-4660.  Results from the Hoe Creek No. 3 underground coal gasification experiment
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  P0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  P0695 N80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PURPS  Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  P0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  P0727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 morrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888  Review of the current status of the wind energy innovative systems projects [SERI/TP-635-469] p0694 N80-28892	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386  TURBOMACHIBENY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 880-2970  TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852  TNO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 880-3075  UUTRASORICS Ultrasonic characterization of coal liquefaction products [DOE/FC-10346/1] p0702 880-3150  UUDERGROUND STRUCTURES Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment p0670 A80-4660  Results from the Hoe Creek No. 3 underground coal gasification experiment
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888  Review of the current status of the wind energy innovative systems projects [SEBL/TP-635-469] p0694 N80-28892  Altos-model 8B wind turbine generator. Failure	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294: MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386: TURBOMACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 N80-2970: TURBULEHT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852: TWO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1]  ULTRASOBICS Ultrasonic characterization of coal liquefaction products [DOE/FC-10346/1] UBDERGROUND STBUCTURES Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment p0670 A80-46600 Results from the Hoe Creek No. 3 underground coal gasification experiment p0675 A80-48340 Theory of reverse combustion along fissures in
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TURBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  P0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  P0695 N80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PURPS  Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  P0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  P0727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 morrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888  Review of the current status of the wind energy innovative systems projects [SERI/TP-635-469] p0694 N80-28892	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 M80-3294: MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 M80-3386.  TURBOMACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 M80-2970:  TURBULEBT WARES Wate decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852.  THO STAGE TURBIBES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 M80-3075:  U  ULTRASOBICS Ultrasonic characterization of coal liquefaction products [DOE/FC-10346/1] p0702 M80-3150: UBDERGROUND STRUCTURES Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  p0670 A80-4660: Results from the Hoe Creek No. 3 underground coal gasification experiment  p0675 A80-4834: Theory of reverse combustion along fissures in fuel which gasifies at depth
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888 Review of the current status of the wind energy innovative systems projects [SEBI/TP-635-469] p0694 N80-28892 Altos-model 8B wind turbine generator. Failure analysis [RFF-3035/3533/79-10] p0742 N80-28525 Small Wind Turbine Systems 1979: A Workshop on R	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294: MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386: TURBOMACHIBERY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 N80-2970: TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852: TWO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1]  ULTRASONICS Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-3150: UNDERGROUND STBUCTURES Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment p0670 A80-4660: Results from the Hoe Creek No. 3 underground coal gasification experiment p0675 A80-4834: Theory of reverse combustion along fissures in fuel which gasifies at depth p0675 A80-4834: A water-influx model for UCG with
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 E80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TORBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375  TURBINE WHERLS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TORBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888  Review of the current status of the wind energy innovative systems projects [SEBI/TP-635-469] p0694 N80-28892  Altos-model 8B wind turbine generator. Failure analysis [RFF-3035/3533/79-10] p0742 N80-28925  Small Wind Turbine Systems 1979: A Workshop on B and D Requirements and Utility	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294  MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386  TURBOMACHIBENT  Field experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  P0697 880-2970  TURBULENT WARES  Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills  P0735 A80-4852  TWO STAGE TURBINES  Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1]  U  ULTRASOBICS  Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1]  UBDERGEOUND STRUCTURES  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  P0670 A80-4660  Results from the Hoe Creek No. 3 underground coal gasification experiment  P0675 A80-4834  Theory of reverse combustion along fissures in fuel which gasifies at depth  A water-influx model for UCG with spalling-enhanced drying Underground Coal
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PURPS  Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DDE/Sandia 17 Darrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888  Review of the current status of the wind energy innovative systems projects [SERI/TP-635-469] p0694 N80-28892  Altos-model 88 wind turbine generator. Failure analysis [RFF-3035/3533/79-10] p0742 N80-28925  Small Wind Turbine Systems 1979: A Workshop on R and D Requirements and Utility Interface/Institutional Issues. Volume 1: R	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386  TURBOMACHIBENY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 880-2970  TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852  TNO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 880-3075  U  ULTRASONICS Ultrasonic characterization of coal liquefaction products [DOE/FC-10346/1] p0702 880-3150. URDERGROUND STRUCTURES Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment p0670 A80-4660. Results from the Hoe Creek No. 3 underground coal gasification experiment p0675 A80-4834 Theory of reverse combustion along fissures in fuel which gasifies at depth A water-influx model for UCG with spalling-enhanced drying Underground Coal
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729]  TORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  PO725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  PO695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2]  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  PO768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  PO727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990]  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] Review of the current status of the wind energy innovative systems projects [SEBI/TP-635-469]  Altos-model 8B wind turbine generator. Failure analysis [RFF-3035/3533/79-10]  PO742 B80-28892  Altos-model 8B wind turbine generator. Failure analysis [RFF-3035/3533/79-10]  PO742 B80-28525  Small Wind Turbine Systems 1979: A Workshop on R and D Requirements and Utility Interface/Institutional Issues. Volume 1: R	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294  MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386  TURBOMACHIBERY  Field experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  P0697 N80-2970  TURBULEHT WARES  Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills  P0735 A80-4852  TWO STAGE TURBINES  Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1]  ULTRASOBICS  Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1]  UBURERGROUND STBUCTURES  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  P0670 A80-4660  Results from the Hoe Creek No. 3 underground coal gasification experiment  P0675 A80-4834  Theory of reverse combustion along fissures in fuel which gasifies at depth  A water-influx model for UCG with spalling-enhanced drying Underground Coal Gasification  P0676 A80-4834
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen beterocycle influence on turbine fuel stability  p0695 E80-29327  Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  TORBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375  TORBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TORBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888  Review of the current status of the wind energy innovative systems projects [SERI/TP-635-469] p0694 N80-28892  Altos-model 8B wind turbine generator. Failure analysis [RFF-3035/3533/79-10] p0742 N80-28925  Small Wind Turbine Systems 1979: A Workshop on R and D Requirements and Utility Interface/Institutional Issues. Volume 1: R and D requirements [RFP-3014-V01-1] p0747 N80-30943	COMMUNITIES through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 880-3294.  MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 880-3386.  TURBOMACHIBENT  Field experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  P0697 880-2970.  TURBULENT WARES  Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills  P0735 A80-4852.  TNO STAGE TURBINES  Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1]  U  ULTRASOBICS  Ultrasonic characterization of coal liquefaction products [DOE/FC-10346/1] p0702 880-3150.  UBDERGROUND STRUCTURES  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  P0670 A80-4660.  Results from the Hoe Creek No. 3 underground coal gasification experiment  P0675 A80-4834.  Theory of reverse combustion along fissures in fuel which gasifies at depth  A water-influx model for UCG with spalling-enhanced drying Underground Coal Gasification  P0676 A80-4834.  UBDERGROUND TRANSMISSION LINES
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PUMPS  Performance and applications potential of a turbine-pump with controlled flow rate —— for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888 Review of the current status of the wind energy innovative systems projects [SERI/TP-635-469] p0694 N80-28892 Altos-model 8B wind turbine generator. Failure analysis [RFF-3035/3533/79-10] p0742 N80-28525 Small Wind Turbine Systems 1979: A Workshop on R and D Requirements and Utility Interface/Institutional Issues. Volume 1: R and D requirements [RFP-3014-VOL-1] Automatic-control system for the 17-metre Vertical Axis Wind Turbine (VAWT)	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 N80-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 N80-3386  TURBOMACHIBERY  Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery  PO697 N80-2970  TURBULENT WARES  Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills  PO735 A80-4852  TWO STAGE TURBINES  Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1]  ULTRASONICS  Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1]  UNDERGROUND STRUCTURES  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  PO670 A80-4660  Results from the Hoe Creek No. 3 underground coal gasification experiment  PO675 A80-4834  Theory of reverse combustion along fissures in fuel which gasifies at depth  PO675 A80-4834  A water-influx model for UCG with spalling-enhanced drying Underground Coal Gasification  PO676 A80-4834
dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357  TORBINE ENGINES  Power production from geothermal brine with the rotary separator turbine  p0725 A80-48266  Mechanisms of nitrogen heterocycle influence on turbine fuel stability  p0695 N80-29327  Aviation turbine fuels, 1979 [DDE/BETC-PPS-80/2] p0703 N80-31627  TURBINE PURPS  Performance and applications potential of a turbine-pump with controlled flow rate for solar and windpower energy storage  p0768 A80-48375  TURBINE WHEELS  Turbulence as experienced by a moving rotor of a wind turbine  p0727 A80-48320  TURBINES  Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-28756  Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1 [ALO-4272-T2] p0578 N80-28888  Review of the current status of the wind energy innovative systems projects [SERI/TP-635-469] p0694 N80-28892  Altos-model 8B wind turbine generator. Failure analysis [RFF-3035/3533/79-10] p0742 N80-28925  Small Wind Turbine Systems 1979: A Workshop on R and D Requirements [RFF-3014-VOL-1] p0747 N80-30943  Automatic-control system for the 17-metre Vertical	communities through power plant retrofit distribution network, volume 4 [COO-4977/1-VOL-4] p0753 M80-3294 MOD-2 wind turbine farm stability study [NASA-CR-165156] p0755 M80-3386  TURBOMACHIBENY Pield experiences with rotordynamic instability in high-performance turbomachinery oil and natural gas recovery p0697 M80-2970  TURBULENT WARES Wake decay and power reduction in wind farm arrays - An application to the array proposed for the Kahuku Hills p0735 A80-4852  TNO STAGE TURBINES Design study of a two-phase turbine bottoming cycle [DOE/ET-15350/T1] p0744 M80-3075  U  ULTRASONICS Ultrasonic characterization of coal liquefaction products [DOE/FC-10346/1] p0702 M80-3150  UBDERGROUND STRUCTURES Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment p0670 A80-4660  Results from the Hoe Creek No. 3 underground coal gasification experiment p0675 A80-4834  Theory of reverse combustion along fissures in fuel which gasifies at depth A water-influx model for UCG with spalling-enhanced drying Underground Coal Gasification p0676 A80-4834  UBDERGROUND TRANSMISSION LINES The dc superconducting power transmission line

•	•
UNDERWATER RESOURCES	Electric utility solar energy activities:
Power extraction from deep ocean waves employing a	1979survey
novel wave energy device	[EPRI-BR-1299-SR] p0631 N80-28879
[ASME PAPER 80-PET-29] p0720 A80-45275	Economics of shale oil production by radio
UNDERWATER STRUCTURES DAM-ATOLL - A system for extracting energy from	frequency heating [UCRL-52942] p0710 N80-32566
ocean waves	District heating and cooling systems for
p0740 A80-53679	communities through power plant retrofit
UNITED RINGDOM	distribution network, volume 4
. Working group on fuel consumption targets	[COO-4977/1-VOL-4] p0753 N80-32942
[NP-24333] p0591 N80-33910	MOD-2 wind turbine farm stability study
UNITED STATES OF AMERICA	[NASA-CR-165156] p0755 N80-33862
Energy choices for the 1980s p0570 A80-47099	V
Impact of electric cars on U.S. petroleum	<b>▼</b>
consumption	VACUUM DEPOSITION
[SAE PAPER 800108] p0773 A80-49726	Research on Cu sub x S/(cd, 2n)S photovoltaic
UPPER ATROSPHERE	solar energy converters
Environmental effects of space systems - A review	[LBL-10791] p0654 N80-32927 VACUUM PUMPS
p0757 A80-46880 UPWELLING WATER	Design of a cost effective solar powered water pump
Kelp farm and OTEC-1 upwelling pipes	[PB90-182819] p0649 M80-31967
p0740 A80-53675	VALUE ENGINEERING
URANIUM	The coating industry: Energy savings with.
The push-pull test - A method of evaluating	volatile organic compound emission control
formation adsorption parameters for predicting	[TID-28706] p0579 N80-29833
the environmental effects on in-situ coal gasification and uranium recovery	Engineering design for Thermocrete central storage. units for low temperature solar application
p0576 A80-52968	[DOB/CS-34702/4] p0638 N80-29883
Overview of nuclear fuel cycle	SPS salvage and disposal alternatives
[CONF-791185-3] p0698 N80-30171	[NASA-CR-161548] p0641 N80-30898
Assumptions and ground rules used in nuclear waste	VANES
projections and source term data	Static investigation of rotor blades at rest and
[ONWI-24] p0585 N80-32203	<pre>- under quasi-stationary loading [ISD-243] p0747 N80-30946</pre>
Uranium resources: A review of estimation methodologies	Stability and dynamic response to gravitational
[PB80-193725] p0714 N80-33920	forces of the flapping and lead-lag hinges on a
URBAN DEVELOPMENT	rigid rotor blade with the leading-edge angle of
Methane production from urban solid wastes	attack and flapping being coupled
p0683 A80-50000	[ISD-244] p0747 N80-30949
Refuse/sludge/hazardous waste co-disposal with	Dynamic analysis of a rotor blade with lead-lag
energy recovery p0684 A80-50020	freedom, flapping freedom, and variable-controlled blade pitch angle
Minimizing consumption of exhaustible energy	[ISD-258] p0747 N80-30950
resources through community planning and design.	VAPOR DEPOSITION
Development of procedures for application during	A proposed slotted mask for direct deposition of
public facilities procurement process. Phase 2:	metal contact pattern on MIS solar cells
Extension	p0595 A80-45119
[RLO-2332-3] p0580 N80-29840	VAPOR PHASES
URBAN PLANNING  Municipal solid waste and district heating - A	Note on the condensation of the vapor phase above a melt of iron oxide in a solar parabolic
case study	· concentrator
p0727 A80-48285	p0611 A80-47664
Assessment of integrated urban energy options	VARIATIONAL PRINCIPLES
[PB80-173644] p0581 N80-30234	Energy principle with global invariants for
District heating and cooling systems for	toroidal plasmas
communities through power plant retrofit distribution network, volume 4	P0717 A80-43973
[COO-4977/1-VOL-4] p0753 N80-32942	Vegetation as an indicator of high wind velocity
URBAN TRANSPORTATION	[RLO-2227-T24-79/1] p0694 N80-28996
Lead-acid traction batteries for electric road	VELOCITY DISTRIBUTION
vehicle propulsion Directions for research and	Convective-radiative interaction in a parallel
development	plate channel - Application to air-operated
p0772 A80-48766	solar collectors
Analysis of the infrastructure for recharging	P0598 A80-46349
electric vehicles [SAE PAPER 800112] p0773 A80-49729	Wind energy capacity of a single airfoil with
UTILITIES	vertical axis on a circular track
Introducing OTEC to mainland utilities	p0673 A80-48274
p0719 A80-44607	Automatic-control system for the 17-metre Vertical
Dc to ac power conditioning for photovoltaic	Axis Wind Turbine (VAWT)
arrays and utility interfacing	[SAND-78-0984] F0750 N80-31958
p0605 A80-46744  Description of photovoltaic village power systems	VIBRATION Rocky Flats Small Wind Systems Test Center
in the United States and Africa	activities. Volume 2: Controlled velocity,
p0609 A80-46796	vibration and dynamometer testing of Small Wind
Photovoltaic central station applications - Status	Energy Conversion Systems
and prospects	[RPP-3004-VOL-2] p0746 #80-30908
p0615 A80-48231	VISCOSITY
Hunicipal solid waste and district heating - A	Thermophysical properties of coal liquids
case study p0727 A80-48285	[BHI-2043] p0701 880-30557
Solar/electric district heating via CASES	Cathode sheaths in potassium seeded MHD combustion
Community Annual Storage Energy Systems	plasmas
p0616 A80-48286	p0720 A80-46158
The OASIS computer program for optimization and	Matching of a radioisotopic thermoelectric
simulation of integrated systems for energy	generator and an energy accumulator
production and utilization at community level p0571 A80-48333	p0720 A80-46599
PG2/1 800-48333	4

p0675 A80-48331

High efficiency transcells and vertical multijunction cells for double-sided	An update on the City of Wankesha energy recovery incinerator plant
concentrated illumination p0606 A80-46768 On the influence of an interfacial oxide layer on	p0670 A80-4759 The combined firing of coal and waste derived fuel in steam raising plant
Au/n-GaAs Schottky barrier solar cells p0608 A80-46784 I-V relationship for the Cu25/CdS solar cell	p0681 A80-4995 Waste handling Rijnmond - Energy production of a large-scale waste incineration plant
p0609 A80-46937 Some electric and photoelectric properties of photodetectors based on epitaxial layers	p0681 A80-4996 The potential in Denmark for substituting natural resources by waste incineration products
Si/x/Ge/1-x/ with diffused p-n junction p0610 A80-47153 Investigation of high-voltage heterophotoconverters	p0682 A80-4997 Integrated system for solid waste disposal with energy recovery and volumetric reduction by new
p0611 A80-47163  Effects of thermal annealing on the deep-level defects and I-V characteristics of 200 keV	pyrolysis furnace p0682 A80-4998
proton irradiated AlGaAs-GaAs solar cells p0613 A80-48204	Riener pyrolysis, a link between waste disposal and energy supply p0682 A80-4998
Development of a high temperature solid electrolyte fuel cell p0726 A80-48281	Possibilities of high temperature waste incineration with the FLK-process p0682 180-4998
Improved alkaline hydrogen/air fuel cells for transportation applications	Brini - A completion to solid fuels municipal solid wastes conversion
p0726 A80-48282 Improvement and scale-up of the WASA Redox storage system	p0684 A80-5001 Refuse/sludge/hazardous waste co-disposal with energy recovery
p0767 A80-48370 Optimized grid patterns for Cu2s-Cds solar cells p0621 A80-49322	p0684 A80-5002  Flue gas recirculation as a means of improving the solid waste incineration process
Evaluation of high temperature LiAl/fiS2 cells p0773 A80-50508	p0688 A80-5305 Trace element characterization of coal wastes
Degradation of solar cell performance by areal inhomogeneity p0624 A80-51112	[PB80-166150] p0577 W80-2846 Energy/Environment 4: Proceedings of the National Conference on the Interagency Energy/Environment
Temperature effects in silicon solar cells p0624 A80-51115	R and D Program [PB80-177942]  Processes to increase utilization of power solid
A six kilowatt transformer-coupled converter for Space Shuttle solar power systems p0616 A80-48262	wastes [ISM-245] p0702 N80-3092
OLTAGE REGULATORS  Computer simulation of solar panel voltage regulation	Organic material emissions from holding ponds at coal-fired power generation facilities [EPRI-PA-1377] p0589 #80-3298 Sorption properties of sediments and
p0612 A80-48177	energy-related pollutants
OLUBE Volume optimization of sodium-sulfur tatteries using various advanced cell concepts	[PB80-189574] p0589 B80-3299 WASTS ENERGY UTILIZATION The tax on waste heat - An instrument of economic
p0764 A80-48236 W	policy for preserving resources p0569 180-4476
APERS	Energy utilization: World Energy Engineering Congress, 2nd, Atlanta, Ga., October 29-31, 1979, Compiled Papers
Pilot line report: Develorment of a high efficiency thin silicon solar cell [NASA-CB-163522] p0644 N80-31876	p0570 180-4758 A synergistic solid waste to energy project - Phase 1 project concept
ALL FLOW Study of the insulating wall boundary layer in a	p0570 180-4758 Methane recovery from urban refuse
Paraday BBD generator p0722 A80-47763 Pseudo-shock as a qualitative model in the	p0670 180-4758 Energy from MSW - The industrial market Hunicipal Solid Waste
investigation of the influence of wall roughness on the performance of supersonic MHD generators [AD-A088333] p0754 N80-33228	p0670 A80-4756 Municipal solid waste as an industrial fuel p0670 A80-4758
ALL TEMPERATURE  Bvaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly	High temperature heat pump applications - Commercial, industrial, and with alternative
to solar radiation p0596 A80-45319	energy sources p0670 180-4759 An update on the City of Waukesha energy recovery
Cost and thermal performance comparisons for wall systems as applied to passive solar building p0628 A80-52842	incinerator plant p0670 A80-4759 Wood energy systems - An assessment
Thermoelectric MHD with walls parallel to the magnetic field	p0670 180-4759 Energy from wood waste - A case study
p0739 A80-52971 ALLS Performance of storage walls with highly	p0670 180-4759 Start-up consideration in utility use of a refuse derived fael
conductive covering plates and connecting films [SEBI/TP-721-574] p0779 N80-32948 Computer modeling of thermal storage walls	p0673 A80-4827 Alternatives for heat supply in biomass energy conversion systems
[SEBI/TP-721-610] p0779 N80-32949 Appraisal of the M factor and the role of building thermal mass in energy conservation	p0673 180-4827 Municipal solid waste and district heating - A case study
[ORNL/COM-46] p0588 880-32958 ASTR DISPOSAL	p0727 &80-4828 The role of refuse derived fuel /BFD/ as an
Factors influencing the release of boron from coal ash materials	alternative energy source for district heating and power generation

p0570 A80-45484

SUBJECT INDEX BASTR TREATMENT

Direct energy conversion for fusion power Thermal energy storage systems using fluidized bed p0729 A80-48361 heat exchangers
[NASA-CR-159868] p0775 N80

Heat-pump-centered integrated community energy p0775 N80-28866 Energy recovery from solid waste for city of Tehran p0681 A80-49948 systems: System development summary
[ANL/CNSV-7] p0578
Design of land-based, foam OTEC plants for Environmental impact of conversion of refuse to p0578 N80-28885 energy D0574 A80-49954 The combined firing of coal and waste derived fuel in steam raising plant bottoming cycles [CONP-799631-17] p0742 N80-28913 p0681 A80-49956 The coating industry: Energy savings with volatile organic compound emission control Co-combustion trials of pretreated solid urban refuse, on a brown coal-fired boiler [1ID-28706] p0579 N80-29833 p0681 à80-49957 Automotive absorption air conditioner utilizing solar and motor waste heat [MASA-CASE-MPO-15183] p0634 M80-Energy savings in a rotary kiln in the production of cement through the addition of domestic waste p0634 N80-29843 and sewage sludge US Department of Energy's methane from landfills p0574 A80-49958 program CONF-7910126-1] The combustion engineering approach to municipal n0701 N80-30558 Design study of a two-phase turbine bottoming cycle [DOE/RT-15350/T1] p0744 #80-3075 solid waste energy recovery p0744 ¥80-30757 Industrial application and assessment of waste The functional use of the heat generated by a refuse incineration plant as exemplified by the RIP Hamburg Stapelfeld energy recovery technologies p0745 880-30886 Thermally driven open-cycle heat pump system [CONF-800549-1] p0582 M80-30938
Solar hot water demonstration project at Red Star Industrial Laundry, Presno, California Waste handling Rijnmond - Energy production of a large-scale waste incineration plant p0681 A80-49963 A refuse incineration plant in combination with [ NASA-CR- 161537 ] p0650 N80-32851 Cogeneration Technology Alternatives Study (CTAS).

Volume 4: Energy conversion systems
[NASA-CR-159768] p0755 N80-338 district heating demonstrated by the Iserlohn p0755 N80-33859 p0681 180-49964 Cogeneration Technology Alternatives Study (CTAS).

Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section A [NASA-CR-159770-PT-1] p0591 N80-338 Cogeneration Technology Alternatives Study (CTAS). Combined production of electrical energy and heat in municipal refuse incinerators in the greater Paris area p0682 A80-49965
Services rendered for waste incineration power
plants technology and implementation exemplified
with the waste incineration heating power plant p0591 N80-33860 Volume 6: Computer data. Part 2: Besidual-fired nocogeneration process boiler Residual-fired nocogeneau-[NASA-CR-159770-PT-2] p0591 N80-3380. Energy conservation-air pollution abatement project p0592 N80-33939 of the seaport of Bremerhaven p0682 A80-49966 Kiener pyrolysis, a link between waste disposal and energy supply Stack gas reheat evaluation [ £B80-196850] p0593 N80-33980 Plants for energy and material recycling p0682 A80-49591 WASTE TREATMENT Large advanced waste treatment plants The Wetox process for energy recovery from sewage sludge and industrial waste streams p0569 A80-44412 A synergistic solid waste to energy project p0683 A80-49998 Phase 1 project concept p0570 A80-47586 Use of gas from landfills for energy recovery -Operating experience at Palos Verdes Energy from MSW - The industrial market -Municipal Solid Waste p0683 A80-49999 Bconomic and technical evaluation of the Ames, Iowa solid waste recovery system Municipal solid waste as an industrial fuel p0670 A80-47589 p0670 A80-47588 p0683 A80-50005 Energy recycling through refuse pelletizing Wood energy systems - An assessment p0683 A80-50008 p0670 A80-47593 Combustible briquets from waste using the Energy from wood waste - A case study PINEDA/LOAS process p0670 A80-47594 p0683 A80-50009 Removal of metals from coal ash p0674 A80-48295 Co-firing densified refuse derived fuel in a The role of refuse derived fuel /RFD/ as an alternative energy source for district heating and power generation spreader stoker fired boiler p0684 A80-50018 Refuse/sludge/hazardous waste co-disposal with p0675 A80-48331 Application of the energy concept to a resource energy recovery New directions in energy recovery from petroleum recovery system p0574 A80-49934 refinery oily sludges p0685 A80-50034
Fuel gas from used tyres by means of the Status report on the research programme \*New processes of thermal waste treatment p0680 A80-49937 Babcock-Rohrbach process p0685 A80-50036 Anatomy of regional solid waste resource recovery The use of refuse heat assisted by heat transformers projects Thermodynamic and economic analysis of heat pumps Energy recovery from solid waste for city of Tehran p0681 A80-49948 Environmental impact of conversion of refuse to for energy recovery in industrial processes
[ASME PAPER 78-WA/HT-64] p0686 A80-52049
Flue gas recirculation as a means of improving the solid waste incineration process energy p0574 A80-49954 Services rendered for waste incineration power D0688 A80-53057 Heat transfer - San Diego 1979; Proceedings of the Eighteenth National Conference, San Diego, Calif., August 5-8, 1979 plants technology and implementation exemplified with the waste incineration heating power plant of the seaport of Bremerhaven D0682 A80-49966 p0781 A80-53568 Effluent-free flue gas scrubbing process to separate the fine dust and the nozious gases Refinery energy profile [ORO-5262-5-SUPPL] p0577 N80-: Comparison of coal-fired power systems in waste p0577 N80-28857

heat applications in Tacona, Washington [TID-29379]

p0693 N80-28858

D0574 - A80-49968

from waste combustion plants

WASTE UTILIZATION SUBJECT INDEX

The gasification of municipal and industrial waste Methane production from urban solid wastes p0683 A80-50000 in accordance with the SFW-PUNK-Process Chemical fuel and raw material production by p0682 A80-49979 Recent developments in a slagging process for thermal processing of refuse Technology and conversion of refuse to energy economics p0684 A80-50010 D0682 A80-49981 Refuse to fuels - An appraisal of thermal processes p0684 A80-50011
Brini - A completion to solid fuels --- municipal Plants for energy and material recycling p0682 A80-49991 Use of gas from landfills for energy recovery solid wastes conversion Operating experience at Palos Verdes  $$\rm p0683~\lambda80\text{-}49999$  Economic and technical evaluation of the  $\lambda \rm mes$  , p0684 A80-50017 Pluidized bed combustion of refuse derived fuels P0684 A80-50019 Iowa solid waste recovery system Energy recycling through refuse pelletizing po683 A80-50008 A method to reclaim metallic material and energy from automobiles p0684 A80-50024 Brini - A completion to solid fuels -- municipal Waste oil as a fuel solid wastes conversion p0684 A80-50032
Why new technology to rerefine waste lubricating oil D0684 A80-50017 Pluidized hed combustion of refuse derived fuels p0684 A80-50019 p0685 A80-50033 Power generation from municipal and industrial wastes with particular reference to sewage Why new technology to rerefine waste lubricating oil p0685 A80-50033 combustion p0685 A80-50815 New directions in energy recovery from petroleum refinery oily sludges Biomass for energy --- Book p0685 A80-50034 Fuel gas from used tyres by means of the Babcock-Bohrbach process p0687 A80-52851 UK Department of Energy Solar Biological Programme Biofuels p0687 A80-52853 p0685 A80-50036 Research, development, and commercialization WASTE OTILIZATION Electric power generation using low temperature geothernal resources and wood residues activities on biomass energy in the United States p0687 A80-52657 P0675 A80-48315 European Community's biomass programme p0687 A80-52859 Recycling World Congress, 2nd, Manila, Philippines, March 19-22, 1979, Proceedings Peasibility of alternatives for surface p0678 A80-49537utilization of coal wastes The producing mechanism, separative and fuel characteristics of municipal refuse [ FE-3105-1] p0692 N80-28563 Overview of nuclear fuel cycle p0679 A80-49539 [CONF-791185-3] p0698 N80-30171 Wood waste gasification as a source of energy Processes to increase utilization of power solid p0679 A80-49540 Wastes Development of a methane fermentation process for [ ISM-245] p0702 N80-30929 Synthetic fuels from municipal, industrial, and organic wastes p0679 A80-49545 agricultural wastes. Citations from the NTIS Energy and material recycling data base p0680 A80-49927 [PB80-811375] p0706 N80-31660 State and tendencies of recycling in North America p0573 A80-49929 Synthetic fuels from municipal, industrial and agricultural wastes. Citations from the American Petroleum Institute data base An analysis of criteria for evaluating proposals for recovery of material and energy from refuse [ PB80-812365] p0711 N80-32579 p0574 A80-49931 Seasonal thermal energy storage Steps to system analysis in waste management [PNL-3322] p0778 N80-32899 [PRI-3322]
International Conference on Air Pollution, volume 3
[ISBN-0-7988-1665-1] p0592 N80-33943 P0574 A80-49932 The conversion of refuse into energy within a regional context Municipal refuse as a fuel for power generation p0714 N80-33950 p0680 A80-49938 Utilization of municipal refuse as an energy source p0714 880-33952 Anatomy of regional solid waste resource recovery projects p0574 A80-49939 WASTE WATER Potential for conversion of refuse to energy in Large advanced waste treatment plants Ontario Canada and the Provincial Energy from p0569 A80-44412 Possible means of cutting energy costs and saving primary energy in waste water purification Waste program P0681 A80-49946 p0575 A80-50818 Organic material emissions from holding ronds at Refuse incineration - A recycling process p0681 A80-49955 coal-fired power generation facilities The advantages of using an incineration regulation system to control the emission of toxic gases and steam generation in refuse incineration plants p0589 N80-32987 WATER p0574 A80-49961 Hydrogen and oxygen from water. III - Evaluation of a hybrid process The potential in Denmark for substituting natural p0661 A80-45298 resources by waste incineration products p0682 A80-49974 Utilization of solar radiation for water photolysis p0661 A80-47667 The quasification of municipal and industrial waste in accordance with the SPW-PUNK-Process High-temperature thermochemical water splitting p0682 A80-49979 cycle fusion reactor design considerations p0663 A80-48449 Recent developments in a slagging process for conversion of refuse to energy A study on utilizing solar energy for hydrogen p0682 A80-49981 Plants for energy and material recycling p0665 A80~53569 p0682 A80-49991 Experimental studies of some regularities in the underground gasification of inclined coal seams [UCRL-TRANS-11585] p0695 N80-29 Biogas from residues of animal husbandry and agricultural plant production p0695 N80-29504 p0683 A80-49994 WATER COESUMPTION The production of substitute natural gas and Twenty years of experience with well-water-source heat pumps at Battelle's Columbus Laboratories recyclables from municipal solid waste p0683 A80-49996 p0733 A80-48481 Biogasification of municipal waste p0683 A80-49997

WAVE PROPAGATION SUBJECT INDEX

Daman nron		DAMED ANALYSMY	
NATER PLOW	`	Proceedings of the Clemen Herkshop	
A water-influx model for UCG with	ground Coal	Proceedings of the Clemson Workshop of Environmental Impacts of Pumped Sto	
spalling-enhanced drying Under Gasification	Alogia cogi	Hydroelectric Operations	rage
003111001201	p0676 A80-48343	[PB80-192453]	p0588 N80-32964
Performance and applications potenti		WATER EUNOPP	
turbine-pump with controlled flow		Evaluation of hydropower potential in	a river basin
solar and windpower energy storage		Prediction analysis technique	
	p0768 A80-48375		p0755 N80-33856
WATER HEATING	-	WATER TEMPERATURE	_
Heat loss and storage functions for	a thermal well	Solar heating and domestic hot water	system
*	p0596 A80-45318	installed at Kansas City, Fire Sta	tions, Kansas
Sizing procedure and economic optimi	zation	City, Missouri	
methodology for seasonal storage s		[ NASA-CR-161513 ]	p0641 N80-30895
	A80-46570	Remote sensing applied to the prospec	
High temperature heat pump applicati		geothermal anomaly in Caldas Novas	County, State
Commercial, industrial, and with a	lternative	of Goias, Brazil	
energy sources		[INPE-1792-RPE/164]	p0712 N80-32837
	p0670 A80-47590	Optimum systems design with random in	
Heat pumps in low temperature applic	ations	output applied to solar water heat	
using geothermal resources		. CLARD ADDIMEDES	p0657 N80-33854
0-4-1-4 1 4-1 6-11	p0723 A80-48184	WATER TREATMENT	
Catalytic combustion of hydrogen in		Possible means of cutting energy cos	
1	p0662 A80-48415	primary energy in waste water puri	
A comparison of the flat plate and o	concentrating	Coll module and final genditioner	p0575 A80-50818
solar collector	-0610 190-00 <b>5</b> 07	Cell module and fuel conditioner	p0749 N80-31882
Cimilarity theory of colon water has	p0619 A80-48507	[NASA-CR-159888] WATER VAPOR	p0749 B00-31002
Similarity theory of solar water hea	iter Artu	A problem posed by vapour-dominated	acethermal
natural circulation	-0631 300-#8 <b>917</b>		geothermar
A stochastic model for predicting so	p0621 A80-48917	systems	p0689 A80-54063
	orar system	WATER WAVES	P0003 R00-34003
performance for water heating	m0621 300-#8921	Wave drift forces on OTEC platforms	
A design method for parallel solar-	p0621 A80-48921	wave drift forces on othe placions	p0740 A80-53676
a design wethou for parallel socal-	p0621 A80-48922	WATERWAVE BHERGY	po/40 200 330/0
Installation quidelines for solar he	• : · · · · · · · · · · · · · · · · · ·	Patent profiles: Solar energy	
single-family residence at William		[FB80-190010]	p0649 N80-31966
Park, Stillwater, Minnesota	Oblies State	WATERWAVE EBERGY CONVERSION	poor 200 21300
[NASA-CR-161480]	p0630 N80-28861	Power extraction from deep ocean wav	es emploving a
Heat-pump-centered integrated commun		novel wave energy device	
systems: System development summa		[ASME PAPER 80-PET-29]	p0720 A80-45275
[ABL/CHSV-7]	p0578 N80-28885	Further analysis of a novel wave ene	•
Solar heating of buildings and domes			p0728 A80-48352
[AD-A085815]	p0634 N80-29532	Describing-function method for estimate	
Assessment of integrated urban energy		performance of a dynamic system ha	
' [PB80-173644]	p0581 N80-30234	nonlinear-power take-off, with app	
Regenerative energy sources for the		wave-power conversion	
low temperature heat: Energy sour		•	p0739 A80-51464
types, and energy conversion; resu		U.S. Department of Energy ocean wave	s and ocean
applications; measures to promote		currents emergy conversion program	
[ISBN-3-7041-0038-2]	p0702 N80-30951		p0740 A80-53678
Solar domestic hot water system, a		DAM-ATOLL - A system for extracting	energy from
study and storage tank investigat:		ocean waves	
	p0643 N80-31868		p0740 A80-53679
Theory and design of an Annual Cycle	e Energy System	Tidal energy in the Bay of Pundy	
(ACES) for residences			p0688 A80-53680
[ORNL/CON-43]	p0587 N80-32904	Ocean wave power available to submer	ged energy
Department of Housing and Orban Deve		devices of finite dimensions	
hot water initiative: Centralized		mia-a	p0689 180-53681
of technical tasks and system eval		Tidal energy and the energy crisis -	
[PB80-189244]	p0656 N80-32961	of technology and the interrelation	
Optimum systems design with random :			p0689 A80-53682
output applied to solar water hear		WATERWAVE POWERED MACHINES	
Denien data burshare for a service	p0657 N80-33854	Further analysis of a novel wave ene	rgy device r0728 A80-48352
Design data brochure for a pyramidal	optical solar	WAVE DISPERSION	PO 1 TO WOO - 4032
system	-04F7 WOD 2206F	Linear analysis of the double-tearin	a mode in
[NASA-CR-161202]	p0657 N80-33865		9 MOUE 1M
Installation package for a sunspot	cascade solar	tokamak discharges	p0718 A80-44390
water heating system	p0657 N80-33866	Parametric decay into ion cyclotron	
[NASA-CR-161562]	t water exetem	drift waves in multi-ion species p	
Design tackage for solar domestic be [NASA-CB-161558]	p0657 N80-33867	diffe and In Edici Ion phooner b	p0735 A80-49071
WATER POLLUTION	P0621 M60-33601	The dispersion relation of electroth	
Large advanced waste treatment plant	+ e	a nonequilibrium magnetohydrodynam	
mando was smooth adopt processis brant	P0569 A80-44412	closed cycle magnetohydrodynamic g	
Pactors influencing the release of i		[TH-78-E-92]	p0744 N80-30198
ash materials		WAVE EXCITATION	
	p0570 A80-45484	Parametric excitation of ion quasi-m	ode by the
The push-pull test - A method of ev		pump near the ion cyclotron freque	
formation adsorption parameters for		heating in tokamaks	- <del>-</del>
the environmental effects on in-s			p0736 A80-49072
<ul> <li>gasification and uranium recovery</li> </ul>		WAVE INTERACTION	•
•	p0576 A80-52968	Nonlinear coupling of the slow wave	
Solubility of selected major and min		the lower-hybrid waves near the pl	
from coal and fly ash accumulation	ns	in controlled fusion	· )
[PB80-175334]	p0580 N80-29926	,	p0720 A80-45291
Sorption properties of sediments and	i	WAVE PROPAGATION	
energy-related pollutants		Wave drift forces on OTEC platforms	
[PB80-189574]	p0589 N80-32997		p0740 A80-53676

WAVELENGTHS SUBJECT INDEX

WAVELENGTHS Theoretical analysis of new wavelength-division	Perspectives on research on LNG vapor cloud dispersion
solar cells p0622 A80-	p0590 N80-33593
WRIGHT REDUCTION	Transient behaviour of wind energy systems
Improvement in stacking structures of fuel cells p0726 180-	
WELD TESTS	[AD-A086506] p0701 N80-30904
Weld overlaying for corrosion resistance in coat gasification atmospheres	Rocky Plats Small Wind Systems Test Center activities. Volume 1: Atmospheric test data
[FE-2621-13] p0711 N80-	
Wast loss and storage functions for a thornal wa	Systems ell [BPP-3004-VOL-1] p0746 H80-30907
Heat loss and storage functions for a thermal we p0596 A80-	
Tar sands and heavy oil reservoir evaluation us:	
geophysical well logs p0671 A80-	vibration and dynamometer testing of Small Wind 8167 Energy Conversion Systems
Hawaii Geothermal Project 'A' wellhead generator	
feasibility project	Small Wind Turbine Systems 1979: A Workshop on B 18316 and D Requirements and Utility
Twenty years of experience with well-water-source	te Interface/Institutional Issues. Volume 1: R
heat pumps at Battelle's Columbus Laboratories p0733 180-	
Design, construction, and operation of a 150 ki	Sites for wind-power installations: Physical
solar-powered irrigation facility, phase 2 [ALO-4159-1] p0645 N80-:	modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.
WIND (METEOROLOGY)	Part 1: Executive summary
Small Wind Turbine Systems 1979: A Workshop on and D Requirements and Utility	R [BLO-2438-78/1] p0706 B80-31900 Analytical studies of wind turbine turning
Interface/Institutional Issues. Volume 1: B	characteristics
and D requirements [RFP-3014-VOL-1] p0747 N80-	[ELO-2439-79/3] p0753 E80-32951
WIND DIRECTION	A practical and economic method for estimating
A practical and economic method for estimating wind characteristics at potential wind energy	wind characteristics at potential wind energy conversion sites
conversion sites	p0670 A80-46569
. p0670 A80-4 Analytical studies of wind turbine turning	16569 Wind resource assessment in the upper Skagit River Valley of Washington
characteristics	p0675 A80-48319
[RLC-2439-79/3] p0753 N80-:	2951 WINDMILLS (WINDPOWERED MACHINES)  Development of a 4 kW wind turbine generator
Implications of the effects of wind	p0725 A80-48269
characteristics on the operation of large wind turbines	Benefits arising from the use of pneumatic energy transmittal in wind-power systems
p0727 A80-	18321 p0757 180-48271
An investigation of wind loads on solar collector [PB80-158744] P0633 N80-	
An investigation of wind loads on solar	p0673 A80-48274
collectors. Appendix 1: Data listing for top and bottom of collector	Feasibility studies of spoiler and aileron control systems for large horizontal-axis wind turbines
[PB80-158751] p0633 N80-2	28937 p0727 A80-48318
Vegetation as an indicator of high wind velocity [RLO-2227-T24-79/1] p0694 N80-2	
Mean wind forces on parabolic-trough solar	p0727 A80-48320
collectors [SAND-80-7023] p0650 M80-3	Implications of the effects of wind
Parabolic trough solar collector wind loading	turbines
[SAND-79-2134C] p0652 N80-3	12895 p0727 h80-48321 The MOD-2 wind turbine
Changes in the potential for wind energy	p0727 A80-48322
generation due to terrain modification of the boundary-layer flow	Transient behaviour of wind energy systems p0734 A80-48521
p0714 N80-3	4020 Small windmills in Denmark
WIND SHEAR Experimental investigation of systems for	p0735 A80-48525 Maximum windmill efficiency
diminishing the structural loads of large wind	p0737 480-50721
turbines p0722 A80-4	Wind tunnel tests on a 3 m diameter Musgrove (7600 windmill
WIND TURNEL TESTS	p0737 A80-50943
Wind tunnel tests on a 3 m diameter Musgrove windmill	Combined effects of periodic and stochastic loads on the fatigue of wind turbine parts, part 6
p0737 A80-5	0943 [PPA-AU-1499-PT-6] p0741 880-28732
Performance of a low cost cross-wind-axis sail-wind turbine	Review of the current status of the wind energy innovative systems projects
p0738 A80-5	1124 [SERI/TF-635-469] p0694 N80-28892
Sites for wind-power installations: Physical modeling of the influence of hills, ridges and	A horizontal axis sail windmill for use in irrigation
complex terrain on wind speed and turbulence.	[NAL-IN-54] p0743 N80-29844
Part 1: Executive summary [BLC-2438-78/1] p0706 N80-3	Rocky Flats Small Wind Systems Test Center 1900 activities. Volume 1: Atmospheric test data
Sites for wind-power installations: Wind	collected from Small Wind Energy Conversion
characteristics over ridges, part 2 [RLO-2438-78/2] p0706 N80-	Systems   1901
mean wind forces on parabolic-trough solar	Rocky Flats Small Wind Systems Test Center
collectors [SAND-80-7023] p0650 N80-3	activities. Volume 2: Controlled velocity, 2790 vibration and dynamometer testing of Small Wind
Line-focus solar central power system, phase 1.	Energy Conversion Systems
Subsystem experiment: Receiver heat transfer [DOZ/ET-20550/1] p0655 N80-	[RFP-3004-VOL-2] · p0746 H80-30908

SUBJECT INDEX NINDPONENED GENERATORS

Sencenbaugh: Hodel 1000-14 wind turbine generator	Wind characteristics program element
[RFP-3034/3533/79-5] p0746 H80-30931	[PNL-3211] p0754 N80-33073
Wind power. Citations from the NTIS data base [PB80-811433] p0748 880-30956	Oversight: Wind energy program [GPO-51-382] p0591 N80-33872
Wind power. Citations from the Engineering Index	WINDPOWERED GENERATORS
data base [PB80-811441]	Low cost composite materials for wind energy conversion systems
Summary of guidelines for siting wind turbine	p0717 A80-44104
generators relative to small-scale,	Preliminary results from the shrouded wind-turbine
two-dimensional terrain features [RLO-2443-77/1] p0647 N80-31930	pilot plant p0722 A80~47525
Wind power. Citations from the NTIS data base	Experimental investigation of systems for
[PB80-811458] p0751 N80-31965 UTRC 8 kW wind turbine tests	diminishing the structural loads of large wind turbines
[RPP-3085] p0752 N80-32722	p0722 A80-47600
WIND: Computer program for calculation of three dimensional potential compressible flow about	Development of a 4 kW wind turbine generator p0725 A80-48269
wind turbine rotor blades	Interim status report on DOE prototype development
[MASA-TP-1729] p0755 M80-33357 The aerodynamics of contra-rotating axial flow	SWECS Small Wind Energy Conversion Systems p0726 A80~48270
wind power turbines	Analysis of small, nonconventional electric power
[CSIR-ME-1638] p0755 H80-33868 WINDPOWER UTILIZATION	systems for remote site applications p0765 A80~48272
Wind energy planning - Development and application	Wind energy for electric vehicle recharge
of a site selection method for wind energy conversion systems /WECS/	p0726 A80~48273 Transient behaviour of wind energy systems
p0719 A80-44676	p0734 A80-48521
A practical and economic method for estimating wind characteristics at potential wind energy	A simulation model for wind electric systems p0734 A80~48522
conversion sites	Wake decay and power reduction in wind farm arrays
p0670 A80-46569 Wind resource assessment in the upper Skaqit River	<ul> <li>An application to the array proposed for the Kahuku Hills</li> </ul>
Valley of Washington	p0735 A80-48523
p0675 A80-48319 Solar and wind energy - Its contribution to	A simulation model for wind turbines p0738 A80~50972
meeting future power requirements	Performance of a low cost cross-wind-axis
p0623 A80-50816 Wind commercialization and Alcoa Vertical Axis	sail-wind turbine p0738 A80-51124
Wind Turbines	Wind commercialization and Alcoa Vertical Axis
p0687 A80-52868 The potential and economics of wind energy - An	Wind Turbines p0687 A80-52868
investigation commissioned by the International	Comparison with strain gage data of centrifugal
Energy Agency for the Federal Republic of Germany p0689 A80-54077	stresses predicted by finite element analysis on the DOB/Sandia 17 m Darrieus turbine
Electric utility solar energy activities:	[SAND-79-1990] p0741 N80-28756
1979survey [EPRI-BB-1299-SR] p0631 N80-28879	Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1
Altos-model 8B wind turbine generator.	[ALO-4272-T2] p0578 N80-28888
Performance report [BFF-3033/3533/79-4] p0742 N80-28926	Review of the current status of the wind energy innovative systems projects
Momentum theory analysis of unconventional wind	[SERI/TP-635-469] p0694 N80-28892
extraction schemes, part 10 [ASBL-TB-194-2-PT-10] p0742 N80-28932	Altos-model 8B wind turbine generator. Pailure analysis
Vegetation as an indicator of high wind velocity	[RFP-3035/3533/79-10] p0742 N80-28925
[RLO-2227-T24-79/1] p0694 N80-28996 A horizontal axis sail windmill for use in	Altos-model 8B wind turbine generator.  Performance report
irrigation	[RFP-3033/3533/79-4] p0742 N80-28926
[NAI-TN-54] , p0743 N80-29844 Screening method for wind energy conversion systems	Safety of wind energy conversion systems (WICS): Preliminary study risk to personnel and to
[SERI/TP-731-649] p0744 N80-29891	the surrounding area due to mechanical failure
Navy-New Hampshire wind energy program [AD-A086506] p0701 N80-30904	[PFA-HU-2126] p0742 N80-28933 Pacific Missile Test Center energy projects.
Dynamic analysis of a rotor blade with lead-lag	Summary of projects, contributions, and plans
freedom, flapping freedom, and variable-controlled blade pitch angle	[AD-A086196] p0581 B80-30903 Design study and economic assessment of multi-unit
[ISD-258] p0747 N80-30950	offshore wind energy conversion systems
Wind power. Citations from the NTIS data base [PB80-811433] p0748 N80-30956	application. Volume 1: Executive summary [WASH-2330-78/4-VOL-1] p0746 N80-30930
Wind power. Citations from the Engineering Index	Sencenbaugh: Model 1000-14 wind turbine generator
data ḥase [PB80-811441]	[RPP-3034/3533/79-5] p0746 N80-30931 Siting handbook for small wind energy conversion
Composite rotor blades for large wind energy	systems
installations [NASA-TM-75822] p0749 N80-31881	[PNL-2521-BEV-1] p0747 N80-30941 Sites for wind-power installations: Physical
Wind power. Citations from the NTIS data base	modeling of the influence of hills, ridges and
[PB80-811458] p0751 N80-31965 Patent profiles: Solar energy	complex terrain on wind speed and turbulence. Part 1: Executive summary
[PB80-190010] p0649 N80-31966	[BLO-2438-78/1] p0706 N80-31900
Capital formation for small wind energy conversion system manufacturers: A guide to methods and	Sites for wind-power installations: Wind characteristics over ridges, part 2
sources	[BLO-2438-78/2] p0706 N80-31901
[SERI/TR-98298-1] p0751 M80-32462 Investigation of the feasibility of using wind	Automatic-control system for the 17-metre Vertical Axis Wind Turbine (VAWT)
power for space heating in colder climates	[SAND-78-0984] p0750 N80-31958
[DOB/DP-03533/T3] p0753 N80-32950 Definition of gust model concept and review of	Large wind turbine generator performance assessment [EPRI-AP-1317] p0751 N80-31960
gust models	UTRC 8 kW wind turbine tests
[PNI-3138] P0712 N80-33072	[RFP-3085] p0752 R80-32722

	Large wind turbines: A utility option	n for	the !
	generation of electricity		
	[HASA-TH-81502]	p0752	N80-32E58
	Analytical studies of wind turbine tu	rning	
	characteristics	_	
	[RLO-2439-79/3]	p0753	N80-32951
	Development of an 8 kW wind turbine g		or for
	residential type application. Phas		Design
	and analysis. Volume 1: Executive		
		p0753	N80-32957
	Wind characteristics program element	0354	
	[PNL-3211]		N80-33073
	MOD-2 wind turbine farm stability stu	ay - o z c c	waa 33063
	[NASA-CR-165156]		N80-33862
	The aerodynamics of contra-rotating a	HIGI I	TOM
	wind power turbines [CSIE-ME-1638]	n0755	N80-33868
	Oversight: Wind energy program	20133	B00-33000
		n0591	880-33872
TI.	IDPOUBRED PUMPS	<b>F</b> 005.	200 330.2
	A horizontal axis sail windmill for u	se in	
	irrigation		•
		p0743	N80-29844
FOC	ם כ	•	
	Wood energy systems - An assessment		
			A80-47593
	Energy from wood waste - A case study		
			<b>A80-47</b> 594
	Peat and wood as fuels - Another form	of so	lar
	energy utilization		
			A80-47595
		indust	
			A80-48275
i	Electric power generation using low t	еврега	ture
	geothermal resources and wood resid		100 #031E
	Wood waste gasification as a source o	puo /5	A80-48315
	wood waste gasification as a source o	PUEZG	99 480-49540
	Wood fuel production experiments in S	HOJON TODON	MOU-45340
	Took thei production experiments in 5	D0687	A80-52854
	Solar gasification of charcoal, wood	and pa	per
	[UCRL-84411]	p0654	N80-32926
	Evaluation of processes for producing		
	from wood	-	
		p0713	N80-33602
HOI	REING PLUIDS		
	Working fluids for solar, Rankine-cyc	le coo	ling
	systems		
			A80-45299
	Condenser designs for binary power cy	cles -	in
	geothermal energy conversion	-0700	
			A80-48221
	Power cycles analyses by generalized properties	CHELMO	dAngmic
	propercies	n0725	A80-48250
	Analysis of binary thermodynamic cycl	es for	a 00 40250
	Analysis of binary thermodynamic cycl moderately low-temperature geotherm	al res	ource
		p0725	A80-48267
	Generalized performance predictions f	or ene	Ida
	conversion plants using geopressure	d geot	hermal
	fluids	-	
			A80-48268
	Regenerative engines with dense phase	worki	ng
	fluids - The Malone cycle		
			A80-48502
	On the selection of working fluids fo	r otec	power
	plants		
			A80-50946
	Optimum working fluids for solar powe	red Ra	DKlDe
:	cycle cooling of buildings	-062E	A80-51681
	Pluid selection for a 100 MW/e/ line		
	central power station	_vcus	SATOT
•		D0630	A60-53572
	1	2000	204 33312

## X

I RAY DIFFRACTION
Methanol and methyl fuel catalyst
[FE-3177-5] p0708 N80-32472
I RAYS
Radiation damage in high voltage silicon solar cells
p0658 N80-33889
IILEBE
The hydropyrolysis of coal to BTI --- Benzene,
Toluene and Iylenes
p0688 A80-53174

Y

TAG LASERS
Reflectance measurements on laser-produced plasmas at 0.26 micron p0741 A80-53870

Z

MINC CHLORIDES

Study on the utilization of solar energy for the operation of Spacelab material science furnaces [DS-EBT-21-79] p0640 880-30349

•

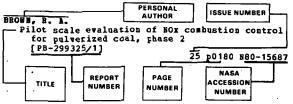
## PERSONAL AUTHOR INDEX

ADBR, G.
Chemical fuel and raw material production by

ENERGY / A Continuing Bibliography (Issue 28)

JANUARY 1981

## Typical Personal Author Index Listing



•		
Listings in this index are arranged alphabetically by pers	onal auth	or. The title
of the document provides the user with a brief description		
The report number helps to indicate the type of docume		
report, translation, NASA contractor report). The issue,		
numbers are located beneath and to the right of the t	itle, e.g.,	25 p0180
N80-15687 Under any one author's name the acc	cession n	umbers are
arranged in sequence with the IAA accession numbers app		
arrenden in sednetice mini the two accession intimets abb	comy ms	٠.
. •		
ASE, D. T.	_	
Assessment of solar thermal concepts	for s	mall
power systems applications .		
	p0618	A80-48463
ABBATIBLIO, L. A.		
Annual Cycle Energy System (ACES)		
[ORNL/CON-42]		N80-32880
Theory and design of an Annual Cycle	Energ	y System
(ACES) for residences		
[ORNL/CON-43]	p0587	N80-32904
ABDEL-MALEK, L. L.		
Optimum systems design with random i	nput a	nd
output applied to solar water heat	ing	
		N80-33854
ABDOU, M. A.	-	
Energy conversion considerations of	the ST.	ARPIRE
commercial fusion power plant		
- •	p0733	A 80-48490
ABELSON, H.		
A thermodynamic analysis of a metal	hydrid	e heat
pump	-	
- ·	p0661	A80-48290
ABERT, J. G.	•	
State and tendencies of recycling in	North	America
		A80-49929
BIDOV, T. Z.	•	
Experimental investigation of therma	1	
characteristics of solar thermoele		lock
		A80-47157
BLOW, C. M.	•	
Shift conversion and methanation in	coal	
gasification: Bench-scale evaluat	ion of	a
sulfur resistant catalyst		
[PE-3240-T5]	p0696	N80-29509
BRAHAH, K. M.		
Some chemistry in the Li/SOC12 cell		
nome chemisti in the nilowin ceri	n077/	A80-51688
CEDDALES D 2	20114	700-71000
CKERNANN, B. A.		
Development of a diaphrage Stirling	endrue	
heat-actuated heat pump	-0724	100 40405
	15/vg	A80-48425
DDBO, A.		
The development of thermal energy st	orage :	systems
exploiting solid-solid phase trans	itions	
	p0774	A80-50970
DELMAH, H.	s	
Methanol/ethanol/gasoline blend fuel	-	
	ge eng:	ine-
Methanol/ethanol/gasoline blend fuel	ge eng	ine
Methanol/ethanol/gasoline blend fuel demonstration with stratified char	ge eng	ine 180-33606.

```
thermal processing of refuse - Technology and
      economics
                                             p0684 A80-50010
   Refuse to fuels - An appraisal of thermal processes p0684 A80-50011
ADLER. D.
   Amorphous silicon solar cells
                                             p0622 A80-50625
   Nickel hydrogen battery advanced development program status report
                                             p0770 A80-48439
ADLER, I. The OASIS computer program for optimization and
      simulation of integrated systems
                                              p0571 A80-48333
ADLER, T. J.
   Interactions between energy supply and
      transportation-related energy use, volume 1
      [PB80-185002]
                                             p0584 N80-31968
ADT, R. R., JR.

Hydrogen engine performance analysis project
p0665 N80-30756
ABBI, V.
   High-efficiency AlGals/Gals concentrator solar
     cells by organometallic vapor phase epitaxy
                                             p0610 A80-46952
AGABARY, C.
Metallic thermoelectric materials in solar
      thermoelectric generators
                                              p0610 A80-47152
AGARUAL, P. D.
   Impact of electric cars on national energy
      consumption
      [SAE PAPER 800111] .
                                              p0573 A80-49728
AGARWAL, R. C.
Pressure loss in a spiral solar energy collector
                                             p0624 A80-50971
   Temperature effects in silicon solar cells
                                             p0624 A80-51115
AGARWALA, A.
   Temperature effects in silicon solar cells
                                             p0624 A80-51115
AGRAWAL, R. C.
Solar energy conversion using CdSe
photoelectrochemical cells with low cost
      substrates
                                             p0597 A80-46253
ABBADI. G.
   Performance of a low cost cross-wind-axis sail-wind turbine
                                             p0738 A80-51124
ARR, Y. K.
   Research and evaluation of biomass
     resources/conversion/utilization systems
      (market/experimental analysis for development of
     a data base for a fuels from biomass model) [DOB/RT-20611/11] p0700 N8
                                             p0700 N80-30552
ABBBBS, P. W.
   Computer aided optimal design of compressed air
    energy storage systems
                                             p0761 A80-45826
   Pulse combustion technology for heating applications [ANL/EES/TH-85] p0707 M80-32467
[ANL/BES/TH-85]
   Highlights of the LLL Hoe Creek No. 3 underground
     coal gasification experiment
                                             F0670 A80-46606

    Solar retorting of oil shale

                                             p0613 A80-48198
   Solar coal gasification
                                             p0616 A80-48243
```

,	•
Results from the Hoe Creek No. 3 underground coal	ALLISON, J.
gasification experiment p0675 A80-48340	Conduction in sputtered a-Si-H Schottky-barrier solar cells
Gasification of coal with solar energy [UCRL-84458] p0643 #80-31652	p0598 A80-46475 Contact formation, scaling and optimisation of
ARIBS, R. R. An investigation of wind loads on solar collectors	large-area R.P. sputtered a-Si Schottky barrier solar-cells
[PB80-158744] p0633 H80-28936 An investigation of wind loads on solar	P0602 A80-46721
collectors. Appendix 1: Data listing for top and bottom of collector	Research needs for coal gasification and coal liquefaction
[PB80-158751] p0633 H80-28937 AKPA HOV, KH. T.	p0688 A80-53274 ALTIHEB, H. E.
Some electric and photoelectric properties of photodetectors based on epitaxial layers	Advanced coal gasification system for electric power generation
Si/x/Ge/1-x/ with diffused p-n junction p0610 A80-47153	[FE-1514-97] p0700 N80-30548
ALAB, H. E. Open-circuit voltage of induced-junction solar cells	Visible light response of polycrystalline TiO2 electrodes
p0622 A80-50758	p0664 A80-51691
ALBANESE, A. S.  Bryironmental control technology for atmospheric carbon dioxide	AMBEGOANKAR, A.  Heat transfer in slurry preheaters for coal liquefaction plants
p0569 A80-45300	p0678 A80-48432
An engineering study on the use of regenerative calcium silicates sorbent for APB power	AMMON, R. L.  Recent progress on the sulfur cycle hybrid
generation from high sulfur coal p0672 A80-48171	hydrogen production process p0663 A80-48460
Environmental control technology for carbon dioxide [DOE/EV-0079] p0588 H80-32972	AMOS, W. J.  A study of industrial hydrogen and syngas supply
ALBERT, E. E. Operation and maintenance cost data for	systems [NASA-CR-163523] p0666 N80-31624
residential photovoltaic modules/panels [MASA-CR-163585] p0650 M80-32855	ANANTH, K. P. Study of thermal energy storage using fluidized
ALESSINDERE, P. The lithium-sulfuryl chloride battery - Discharge	bed heat exchangers p0764 180-48240
behaviour p0772 180-48770	ANDERSEB, N. B. JT9D-7A /SP/ jet engine performance deterioration
ALEXANDER, A. G. Production of sugarcane and tropical grasses as a	trends p0569 180-44230
renewable energy source [ORO-5912-T3] p0699 N80-30543	ANDERSON, J. C. Energy from HSW - The industrial market
ALIKHANOV, S. G. Magnetic-pressure acceleration of cylindrical	p0670 A80-47588
liners by the pulse generators for relativistic electron beams	A design method for parallel solar-heat pump systems p0621 A80-48922
p0736 A80-49098 .	ANDERSON, K. B. Evaluation of high temperature LiAl/TiS2 cells
Conduction in sputtered a-Si-H Schottky-barrier solar cells	p0773 A80-50508
p0598 A80-46475	Analysis of small, nonconventional electric power
Contact formation, scaling and optimisation of large-area R.P. sputtered a-Si Schottky barrier	systems for remote site applications p0765 A80-48272
solar-cells p0602 A80-46721	ANDERSOE, R. P. Disposable catalysts in the solvent refined coal
ALKAITIS, S. A.	processes p0676 A80-48381
Hydrogen production by photoelectrolytic decomposition of H2O using solar energy	ANDRESON, R. A.
[NASA-CR-163586] p0667 N80-32854 ALLAN, A. P.	Deposition, fabrication and analysis of polycrystalline silicon MIS solar cells
A review of the methods for passive solar systems analysis	[DOE/ET-23044/4] p0653 880-32920 ANDERSSON, B.
[AD-A087509] p0645 #80-31895 ALLAM, J. B.	Human comfort and auxiliary control considerations in passive solar structures
Design and flight performance of the Pioneer Venus  Bultiprobe and Orbiter solar arrays	[LBL-10034] p0640 H80-29903 ANDRES, J. B.
p0614 A80-48212 ALLBACH, W. G.	Solar assisted heat pump program overview and summary of work at Brookhaven Hational Laboratory
Steam engine analysis [FE-8917-2] p0743 N80-29741	[BHL-27662] p0642 880-30926 AMG, P. G. P.
ALLEE, B. R. Carbohydrate crops as a renewable resource for	Electrochemical photovoltaic cells, project 65021 [DSE-4042-T8] p0742 M80-28910
fuels production. Volume 3: Juice preservation [BHI-2031-VOL-3] p0696 B80-29511	ANGELICI, G. L. Urban solar photovoltaics potential: An inventory
ALLES, R. D.	and modelling study applied to the San Fernando Valley region of Los Angeles
Porous media experience applicable to field evaluation for compressed air energy storage	[NASA-CR-163436] p0636 N80-29859
[PNI-3294] p0777 H80-32873  ALLEE, R. J.  Proper covings by money of fuel cell electrodes in	ANGEVINE, P. J. Upgrading of coal liquids for use as power
Bnergy savings by means of fuel cell electrodes in electro-chemical industries	generation fuels [EPRI-AF-1225] p0699 #80-30547
[COO-4881-12] p0745 880-30902	ANGINO, B. B. Solubility of selected major and minor elements
Costing methodologies for energy systems [BNI-27603] p0778 N80-32900	from coal and fly ash accumulations [PB80-175334] p0580 880-29926
ALLER, R. P. Hethane production from urban solid wastes	ABGURT, J. Study of sandwich type glass encapsulation
p0683 A80-50000	

ABGUS, S. G. Seasonal thermal energy storage of chilled water in aguifers D0766 A80-48335 Improved components for engine fuel savings P0583 880-31402 [ BASA-TH-81577 ] APLEY, W. J. Assessment of solar thermal concepts for small power systems applications p0618 A80-48463 ABERDI, B. H.
Alternate synthesis of electrolyte matrix for
molten carbonate fuel cells P0721 A80-47135 Alternate fabrication process for molten carbonate fuel cell electrolyte structures p0721 A80-47136 ARRESON, S. Solar thermal heating and cooling. A bibliography with abstracts [ NA SA-CR-163535 ] D0649 N80-31963 ARGYRIS, J. B.
Static investigation of rotor blades at rest and under quasi-stationary loading [ISD-243] P0747 N80-30948 Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled [ISD-244] p0747 880-30949 Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle P0747 N80-30950 [ISD-258] ARJOHA, R.
Optical and calorimetric measurements of cupreous sulphides thin films P0607 A80-46779 AlSb as a potential photovoltaic material p0608 A80-46786
Reactively sputtered thin film cu/sub x/S/CdS photovoltaic devices [UCID-18592] p0637 N80-29875 ARMATTROUT, J. D.
The Intelsat V nickel- cadmium battery system p0769 A80-48395 ARMITO, J. R. Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal tattery [SAND-79-2148C] p0746 880-30933 ARBSTROMG, A. A.
A high volume process for silicon solar cells
using solid diffusion sources p0601 A80-46707 ARMSTRONG, R. W.
Investigation of the impurity tolerance of
semicrystalline silicon solar cells silicon impact program
[DOE/CH-00178/T2] p0654 N80-32934 ARNDT, E. Status of nuclear high temperature process heat development in the Federal Republic of Germany /coal gasification and long distance energy transport/ D0758 A80-48311 ARNDT, G. D. Solar power satellites - The present and the future p0757 180-47562 Integrated Cu2S-CdS thin film solar cell generator p0606 A80-46770 Determination of the spectral distribution of global radiation with a rapid spectral radiometer and its correlation with solar cell efficiency p0608 A80-46789 ARBETT, J. C. Testing flat plate photovoltaic modules for terrestrial environment p0608 A80-46788 ARHOLD, J. B., JR.
Changes in the potential for wind energy
generation due to terrain modification of the
boundary-layer flow

AROBSTY, J. A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications B-2595-DOE1 p0749 N80-31885 ARRECLA, J. I.

Degradation of solar cell performance by areal inhomogeneity p0624 A80-51112 ARTHURS, M. J. Advanced coal gasification system for electric power generation (FR-1514-97) p0700 N80-305
ARUHI-MOR, A.
DEROB - A system for simulating the dynamic energy D0700 N80-30548 performance of passive solar structures
[ASME PAPER 80-HT-21] n061 D0612 A80-48011 Advanced battery development at General Blectric p0764 A80-48234 ATKINSON. C. Optimum OTEC design and sensitivity analysis using geometric programming n0741 A80-53688 ATTREBERGER, S. B. Neutral-beam energy and power requirements for expanding-radius and full-bore start-up of DO719 A80-44656 AUBORN; J. J. Sodium-sulfur-aluminum chloride cells D0764 A80-48238 AURIAN-BLAJENI, R. Semiconductor-electrolyte solar cells for the photoelectrochemical reduction of carbon dioxide to organic fuel p0605 A80-46755
Photoreduction of carbon dioxide and water into
formaldehyde and methanol on semiconductor materials p0621 A80-48923 AUTHIER, B.

High concentration solar collector of the stepped spherical type - Optical design characteristics p0629 A80-53263 AVERBURE, T. G.
Theoretical investigations into collection coefficient for Cu/2-x/S-CdS cells with allowance for surface states at interface p0610 A80-47151 AVERY, S. H. Projected costs for electricity and products from OTEC facilities and plantships p0728 A80-48349 Ocean thermal energy conversion contribution to the energy needs of the United States n0737 480-50909 AVEZOV, P. B. Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems AXELL, B. A.
The MOD-2 wind turbine p0727 A80-48322 AYRES, L. Worldwide transportation/energy demand, 1975-2000: Revised Variflex Model projections [OBNL/SUB-79/45740/1] p0578 880-289 n0578 N80-28915 ATRES, R. U.

Norldwide transportation/energy demand, 1975-2000:

Revised Varifler Model projections

[ORML/SUB-79/45740/1] p0578 N80-289 n0578 N80-28915 AZIHOV, O. Calculation of heat-transport-medium flow rate in heat receivers of passive solar-heating systems p0611 A80-47159 BAADER, W. Biogas from residues of animal husbandry and agricultural plant production p0683 A80-49994

Thermodynamic analysis of coal gasification

BABU. S. P.

p0714 N80-34020

processes

p0686 A80-51210

BACL, G. A.	BALDWIN, D. B.
Assessment of environmental control technologies	Large wind turbines: A utility option for the
for energy storage systems, 1979	generation of electricity
[LA-8308-MS] p0588 M80-32973 BACCAGLINI, G.	[HASA-TH-81502] p0752 H80-32858 BALLHRIM, R. W.
Solaroil project. Phase 1: Preliminary design	The 3% Compound Parabolic Concentrating (CPC)
report	solar energy collector
[GA-A-15823] p0633 H80-29505	[DOE/CS-04239/T1] p0655 #80-32944
BACKUS, C. B. Terrestrial photovoltaic power systems with	BALLOU, H. L. Theory and design of an Annual Cycle Energy System
sunlight concentration	(ACES) for residences
[SAND-80-7008] p0648 N80-31942	[OBML/COM-43] p0587 M80-32904
BADER, M.	BALTISBERGER, R.
Prospects for using solar energy to power materials-science furnaces in space	Chemistry of lignite liquefaction (PE-2211-11) p0704 B80-31642
p0599 A80-46688	BARRET, K.
Study on the utilization of solar energy for the	The behavior of a closed-cycle gas turbine with
operation of Spacelab material science furnaces	time dependent operating conditions
[DS-ERT-21-79] p0640 H80-30349	[ASHE PAPER 79-GT/ISR-2] p0720 A80-45663
BADESCU, V. The optimal interconnection of solar collectors in	BANDA, B. B. Design study of a coal-fired thermionic
air heating systems with large collector surfaces	/THI/-topped power plant
p0620 A80-48794	p0730 A80-48422
BARRY, D.	BANI, J.
Influence of meteorological conditions on the	Dimensionless groupings for photovoltaic
design of solar energy dc-ac inverters p0609 A80-46795	performance analysis p0624 A80-51463
BAGHDADI, A.	BANUART, W. L.
Potential for improved silicon ribbon growth	Sorption properties of sediments and
through thermal environment control	energy-related pollutants
p0601 A80-46704	[PB80-189574] p0589 N80-32997
BAILIE, B. C. Research and evaluation of biomass	BARBR, H. CdTe homojunctions solar cells
resources/conversion/utilization systems	p0603 A80-46731
(market/experimental analysis for development of	BARBER, R. E.
a data base for a fuels from biomass model)	Solar powered rankine cycle irrigation pump
[DOE/ET-20611/11] p0700 N80-30552 BAILLIE, A. L. H.	[DOE/ET-20419/1] p0652 880-32892 BARBERIS, N.
Energy conservation-air pollution abatement project	Insat-I solar array - Design and development summary
p0592 N80-33939	p0615 A80-48213
BAILLIEUL, D. B.	BARCRET, W. B.
Feasibility study: Fuel cell cogeneration in a	Wind characteristics program element [PNL-3211] p0754 N80-33073
water pollution control facility, volume 1 [DOB/ET-12431/T1-VOL-1] p0749 N80-31522	[PNL-3211] p0754 N80-33073 BARKATS, G.
BAIHATOV, T.	SPOT solar array
Experimental investigation of thermal	p0658 N80-33880
	BARLON, R. S.  Hanual and programmable calculator methods for
p0611 A80-47157 BARER, C. C.	sizing solar energy systems
Energy conversion considerations of the STABFIER	[EPRI-ER-1282-SR] p0632 N80-28890
connercial fusion power plant	BARNES, P. R.
p0733 A80-48490	Roof overhang design for solar control [CONF-791022-15] p0632 N80-28900
PARRE, R. W.  Vegetation as an indicator of high wind velocity	[CONF-791022-15] p0632 M80-28900 Passive solar heating and natural cooling of an
[BLO-2227-T24-79/1] p0694 N80-28996	earth-integrated design
BAKKE, B.	[CONF-800449-1] p0638 N80-29884
Application of the lime/limestone flue gas	BARBETT, A. B.
desulfurization process to smelter gases p0576 A80-53084	Thin film solar cells p0619 A80-48513
BALABAN, H. H.	BARBETT, L. W.
A quantitative evaluation of closed-cycle ocean	Test data analysis and application of nickel
thermal energy conversion (OTEC) technology in	hydrogen cells
central station applications [R-2595-DOB] p0749 880-31885	P0771 A80-48446
BALBERG, I.	Recent progress in lithium/iron sulfide battery
Amorphous thin films for solar-cell applications	development
[DOE/ET-21074/4] p0653 880-32921	p0762 A80-48188
BALCOMB, J. D. Trombe wall vs direct gain - A comparative	Status report on the research programme New
analysis of passive solar heating systems	processes of thermal waste treatment
p0626 A80-52828	p0680 A80-49937
The effect of design parameter changes on the	BARR, G. N.
performance of thermal storage wall passive	Pulsed power accelerators for particle beam fusion [SAND-80-0550C] p0715 #80-34239
systems \bar{\chi} p0626 A80-52829	BARR, N. P.
A semi-empirical method for estimating the	An environmental assessment of the satellite power
performance of direct gain passive solar heated	system reference design
buildings	p0757 180-46396
p0627 A80-52838 Energy savings obtainable through passive solar	BARTEL, L. C. Characterization of a potential underground coal
techniques	gasification site in the State of Washington
[LA-UR-80-746] p0632 N80-28891	p0676 A80-48345
BALDUIN, A. B.	BARTH, B. A.
Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal tattery	Evaluation of the Ram-Jet device, a PCV air bleed [PB80-170657] p0582 B80-30964
[SAND-79-2148C] p0746 H80-30933	
	BARTHBLERY, B.
•	Air Force space power technology program

·				
ARTHOLOMEW, C. H.		BECKER, J. D.		
Alloy catalysts with monolith suppor- methanation of coal-derived gases		A multi-site magnetotelluric measure with real time data analysis	-	
[PE-2729-8] Investigation of sulfur-tolerant cata		BECKER, M.	p0714 N80-339	188
selective synthesis of hydrocarbon coal-derived gases	•	Upgrading of coal liquids for use as generation fuels	•	
ARTON, L. M.	,p0702 N80-31502	[EPRI-AP-1225] BRCKHAH, W. A.	p0699 N80-305	
Feasibility study: Fuel cell cogener water pollution control facility,	volume 1	A design method for parallel solar-h	eat pump syste p0621 A80-489	
[DOE/ET-12431/T1-VOL-1] ASBLT, J. P.	p0749 R80-31922	The Engineering Test Facility - The	next major	
Study on the utilization of solar encoperation of Spacelab material sci	ence furnaces	development in the U.S.A. fusion p	rogram : p0733 180-484	491
[DS-ERT-21-79] Asim, iu. G.	P0640 N80-30349	Use of an automated mass spectromete	r for an	
Matching of a radioisotopic thermoel generator and an energy accumulato	r	underground coal gasification fiel [UCRL-84366]	d test   p0709 N80-325	56 <b>5</b>
ASS, J.	p0720 A80-46599	An emissometer with high accuracy for	r .	
Solaroil project. Phase 1: Prelimi report	nary design	determination of the total hemisph emittance of surfaces		
[GĀ-A-15823] AST. J. A.	p0633 N80-29505	BEHRENS, G. P.	p0621 A80-489	947,
Advanced battery development at Gene	ral Blectric p0764 A80-48234	Stack gas reheat evaluation [PB80-196850]	p0593 N80-339	980
ATTOS, W. D. Solar-powered Bankine engine assists conditioning systems with electric		BRHRRES, R. C.  Hydrogen production from the solar b  cadmium cycle	ased LASL	
capability	p0611 A80-47596	BRHRIW, B.	p0662 A80-484	116
Solar powered rankine cycle irrigation [DOE/ET-20419/1]		An analysis of aluminum-air battery systems for passenger vehicles	propulsion	
AUER, E. K. International energy indicators		Comparative analysis of aluminum-air	p0771 A80-484 battery	171
[DOE/IA-0001T/3(80)] AUER, R.	p0781 N80-28919	propulsion systems for passenger v [UCRL-52933]		907
Development of sodium sulfur batteri	es p0776 N80-29905	Analysis of aluminum-air battery pro systems for passenger vehicles		
AUR, G.	_	[UCRL-83824]	p0778 N80-329	940
Fluorescent planar concentrators - Per experimental results	p0604 A80-46741	BEIN, J.  MHD electrode development [PE-15529-5]	p0748 N80-312	222
AICB, A. B. Direct electrochemical generation of	-	BEJAN, A.  End-use matching of solar energy sys		
from coal	p0752 N80-32865	BELL, H. A.	p0624 A80-512	208
AZAROV, B. A. Investigation of high-voltage hetero	photoconverters	Thermal energy storage using saturat solutions	ed salt	
AZELOH, D. L.	p0611 A80-47163	BELL, R. O.	p0,774 A80-511	125
The outlook for nuclear power	p0579 N80-29156	Ion implanted solar cells from EFG s	ilicon ribbons p0601 A80-467	3 305
RWCHTRI' H" H"	•	BELLAS, G. T.	•	, 03
Plywheel energy management systems for the fuel economy of motor vehicles [PB80-175300]		Recent coal-oil mixture combustion t [DOE/PETC-TR-80/5] BELLOWS, R. J.	p0706 N80-316	558
BALE, W. T. Stirling engines for developing coun	_	Development of a bipolar Zn/Br2 batt	ery p0767 A80-483	260
	p0732 A80-48454	BELOURT, C.		14 3
RATTIE, W. H.  Flash pyrolysis and gasification of laser heating	coal through	Early assessment of the photovoltaic potentialities of RAD polysilicon		701
	p0672 A80-48244	BENDAHILLO, V.	· .	.,
Flash pyrolysis and gasification of laser heating		Research needs for coal gasification liquefaction		
[LA-UR-80-1094] RAUCHAMP, W. T.	p0711 N80-32573	BENDER, D. J.	p0688 A80-532	274
An evaluation of spectrally selective (cold mirror membranes) for use wi		Parametric study of prospective earl OCMHD power plants /PSPEC/		• • •
concentrator solar arrays	p0659 N80-33900	BRUDT, P.	p0717 A80-441	106
BAUCOURT, C. Capital requirements for the develop	ment in the	Effect of circumsolar radiation on p focusing collectors	erformance of	
field of energy in the Bastern Bur countries on the eve of the nineti	es	[SERI/TR-34-093] Optical analysis of point focus para	p0646 #80-319 bolic	316
BBERMBIRR, H.	p0572 A80-49394	radiation concentrators [SERI/TR-631-336]	p0646 N80-319	<del>3</del> 17
Potential use of terrestrial photovo future space solar arrays	p0658 N80-33882	Solar energy conversion through biop [SAN-0034-239-1-T2]	hotolysis p0666 %80-319	927
Comparison of silicon solar cell cha at operating temperature after ele	racteristics	BENERATI, B. HYPIRE - Pusion-high temperature ele	ctrolysis syst	tem
irradiation	p0659 880-33890	BENHAN, C.	p0731 A80-484	
	•	Integrated solar receiver/biomass ga [SERI/TP-333-507]	sifier researd p0630 N80-285	

•			
BENEETT, L. E.		BHATT, B.	
Materials for fuel cells [PB80-182355]	p0748 #80-30955	Reaction modelling and correlation for hydropyrolysis of lignite	flash
BENNETT, W. S.	p0140 200 30333		0678 A80-4843
Assessment of environmental control	technologies	The flash hydropyrolysis of lignite and	
for energy storage systems, 1979 [LA-8308-MS]	p0588 N80-32973	sub-bituminous coals to both liquid a hydrocarbon products	and gaseous
BEBOIT, A. B.	, pusou nou nastra		0679 A80-4962
The 100-kep photovoltaic power syst	em at Natural	BHATTACHARJER, A.	
Bridges National Monument	p0615 A80-48227	Energy principle with global invariant: toroidal plasmas	s tor
BENSON, D. K.	p0015 200-40227		0717 A80-4397
Thermoelectric OTEC - An update		BHUMBALKAR, C. M.	
BENSON, G.	p0731 A80-48436	A practical and economic method for establishment wind characteristics at potential winders.	
Analysis and design of free-piston	Stirling	conversion sites	nd energy
engines - Thermodynamics and dyna			0670 A80-4656
Applications of free-piston Stirlin	p0729 A80-48407	Test evaluation of a prototype 18-ton :	solar
nit	p0732 A80-48456	powered heating and cooling system	
An advanced 15 kW solar powered fre	e-piston		0619 A80-4848
Stirling engine	p0619 A80-48467	Estimated performance of an electrohyd	rodvnamic
BENTINI, G. G.		power generator which utilizes a two-	-fluid ejecto
Effect of laser irradiation on the			0717 A80-4412
of implanted layers for silicon s	p0602 A80-46711	BICKLER, D. B. A preliminary 'test case' manufacturing	a sequence
BERCHIELLI, A. S.	•	for 50 cents/watt solar photovoltaic	
Nickel hydrogen battery for load le	veling	1986	0607 180 <u>-</u> 0677
application	p0766 A80-48328	BIEN, P.	0607 A80-4677
BERGEROH, K. D.	Ξ,	Characterization of open-cycle, coal-f	ired MHD
Line-focus solar thermal energy tec		generators [ARI-RP-43] pt	0750 N80-3193
development. Report for Departme [SAND-80-0865-REV]	p0651 N80-32887	Characterization of open-cycle, coal-f	
BERGERON, P.	-	generators	
Integrated solar receiver/biomass g [SRHI/TF-333-507]	p0630 N80-28565	[ABI-BP-46] po	0751 N80-3223
BERJOAN, R.	p0030 H00 20303	Recent coal-oil mixture combustion test	ts at PETC
Solar gasification of charcoal, woo			0706 N80-3165
[UCRL-84411] BERMAH, P. A.	p0654 N80-32926	BIPABO, W. J.  Description of photovoltaic village por	wer systems
The applicability of DOE solar cell	and array	in the United States and Africa	1
tacksalass to massa source			0609 A80-4679
technology to space power	-0443 200 40304		0003 200 4013
	p0613 A80-48206	BIGA, A. J.	
BERNABEL, S. Transport code simulations of lower	-	BIGA, A. J. Estimating solar irradiation sums from and cloudiness observations	sunshine
BERNABEL, S.	hybrid heating	BIGA, A. J. Estimating solar irradiation sums from and cloudiness observations	
BRRWABEL, S. Transport code simulations of lower in tokamaks	-	BIGA, A. J. Estimating solar irradiation sums from and cloudiness observations	sunshine 0625 180-5168
BERNABEL, S. Transport code simulations of lower in tokamaks  BERNI, G. F. Development of steam generator comp	hybrid heating	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, P.  Analysis of the influence of geography on parabolic trough solar collector of the second solar	sunshine 0625 A80-5168 and weather design
BRRWABEL, S. Transport code simulations of lower in tokamaks  BERRY, G. F. Development of steam generator compopen-cycle MHD	hybrid heating p0719 A80-44664 onents for	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  PIGGS, P.  Analysis of the influence of geography on parabolic trough solar collector ([SAND-79-2032])	sunshine 0625 A80-5168 and weather
BRRWABEL, S. Transport code simulations of lower in tokamaks  BERRY, G. F. Development of steam generator compopen-cycle MHD	hybrid heating	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, P.  Analysis of the influence of geography on parabolic trough solar collector of the second solar	sunshine 0625 A80-5168 and weather design 0631 N80-2887
BRRWABEL, S. Transport code simulations of lower in tokamaks  BERRY, G. F. Development of steam generator compopen-cycle MHD  BERRYMAN, M. S. Tidal energy and the energy crisis	hybrid heating p0719 A80-44664 onents for p0723 A80-48186 - An assessment	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, P.  Analysis of the influence of geography on parabolic trough solar collector ([SAND-79-2032] pt.  BIKADI, L.  Conceptual design of BSI: An rf-driver steady-state Tokamak	sunshine 0625 A80-5168 and weather design 0631 N80-2887
BERNABEL, S.  Transport code simulations of lower in tokamaks  BERNY, G. F.  Development of steam generator compopen-cycle MHD  BERNYMAN, M. S.	hybrid heating p0719 A80-44664 onents for p0723 A80-48186 - An assessment onship	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, P.  Analysis of the influence of geography on parabolic trough solar collector ([SAND-79-2032]]  BIKADI, L.  Conceptual design of BST: An rf-driver steady-state Tokamak [EPRI-AP-1351] pt	sunshine 0625 A80-5168 and weather design 0631 N80-2887
BRRNABRI, S.  Transport code simulations of lower in tokamaks  BERRY, G. F.  Development of steam generator compopen-cycle MHD  BERRYHAM, M. S.  Tidal energy and the energy crisis of technology and the interrelating BERTINO, J. P.	p0719 A80-44664 onents for p0723 A80-48186 - An assessment onship p0689 A80-53682	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, P.  Analysis of the influence of geography on parabolic trough solar collector (SAND-79-2032)  BIKADI, L.  Conceptual design of RST: An rf-driven steady-state Tokamak [EPRI-AP-1351]  BILGER, G.  Integrated Cu2S-CdS thin file solar cells	sunshine 0625 A80-5168 and weather design 0631 N80-2887 n, 0751 N80-3223
BRRNABRI, S. Transport code simulations of lower in tokamaks  BERRY, G. P. Development of steam generator compopen-cycle MHD  BERRYHAM, M. S. Tidal energy and the energy crisis of technology and the interrelati  BERTINO, J. P. Trace element characterization of compositions of the composition of composition of compositions of the composition of compositions of the composition of compositions of the composition of the comp	hybrid heating p0719 A80-44664 onents for p0723 A80-48186 - An assessment onshir p0689 A80-53682 oal wastes	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, P.  Analysis of the influence of geography on parabolic trough solar collector ([SAND-79-2032]]  BIKADI, L.  Conceptual design of BST: An rf-driver steady-state Tokamak (EPRI-AP-1351) pt  BILGER, G.  Integrated Cu2S-CdS thin film solar cere	sunshine 0625 A80-5168 and weather design 0631 N80-2887 n,
BRRNABRI, S.  Transport code simulations of lower in tokamaks  BRRNI, G. F.  Development of steam generator compopen-cycle MHD  BERRIANA, M. S.  Tidal energy and the energy crisis of technology and the interrelati  BERTINO, J. P.  Trace element characterization of composition of the composition of	p0719 A80-44664 onents for p0723 A80-48186 - An assessment onship p0689 A80-53682	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, F.  Analysis of the influence of geography on parabolic trough solar collector (SAND-79-2032)  BIKADI, L.  Conceptual design of RST: An rf-driven steady-state Tokamak [EPRI-AP-1351]  BILGER, G.  Integrated Cu2s-CdS thin film solar centre in the state of t	sunshine 0625 A80-5168 and weather design 0631 N80-2887 n, 0751 N80-3223
BRRNABRI, S. Transport code simulations of lower in tokamaks  BERRY, G. F. Development of steam generator compopen-cycle MHD  BERRYAM, M. S. Tidal energy and the energy crisis of technology and the interrelatification of technology and the interrelation of capacity (PB80-166150)  BERTOLACIBI, R. J. Catalyst development for coal lique	hybrid heating p0719 A80-44664 onents for p0723 A80-48186 - An assessment onshir p0689 A80-53682 oal wastes p0577 N80-28488 faction	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, P.  Analysis of the influence of geography on parabolic trough solar collector ([SAND-79-2032]]  BIKADI, L.  Conceptual design of RST: An rf-driver steady-state Tokamak ([EPRI-AP-1351]) pt  BILGER, G.  Integrated Cu2s-Cds thin film solar certain second companies of the second c	sunshine 0625 A80-5168 and weather design 0631 N80-2887 n, 0751 N80-3223
BRRNABRI, S.  Transport code simulations of lower in tokamaks  BRRNI, G. F.  Development of steam generator compopen-cycle MHD  BERRYANA, M. S.  Tidal energy and the energy crisis of technology and the interrelati  BERTINO, J. P.  Trace element characterization of composition of the composition of	p0719 A80-44664 onents for p0723 A80-48186 - An assessment onshir p0689 A80-53682 oal wastes p0577 N80-28488	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, F.  Analysis of the influence of geography on parabolic trough solar collector (SAND-79-2032)  BIKADI, L.  Conceptual design of RST: An rf-driven steady-state Tokamak [EPRI-AP-1351]  BILGER, G.  Integrated Cu2s-Cds thin film solar ceimage of the state of	sunshine 0625 A80-5168 and weather design 0631 N80-2887 n, 0751 N80-3223 11 generator 0606 A80-4677
BRRNABRI, S. Transport code simulations of lower in tokamaks  BERRY, G. F. Development of steam generator compopen-cycle MHD  BERRYAM, M. S. Tidal energy and the energy crisis of technology and the interrelatification of technology and the interrelation of capacity (PB80-166150)  BERTOLACIBI, R. J. Catalyst development for coal lique	p0719 A80-44664 onents for p0723 A80-48186 - An assessment onshir p0689 A80-53682 oal wastes p0577 N80-28488 faction p0696 N80-29508	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, P.  Analysis of the influence of geography on parabolic trough solar collector ([SAND-79-2032]]  BIKADI, L.  Conceptual design of RST: An rf-driver steady-state Tokamak ([EPRI-AP-1351]) pt  BILGER, G.  Integrated Cu2s-Cds thin film solar certain second companies of the second c	sunshine 0625 A80-5168 and weather design 0631 N80-2887 n, 0751 N80-3223 11 generator 0606 A80-4677
BRRNABRI, S. Transport code simulations of lower in tokamaks  BRRRY, G. F. Development of steam generator componencycle MHD  BERRYMAN, M. S. Tidal energy and the energy crisis of technology and the interrelation of technology and the interrelation of component (PB80-166150)  BRRTOLACINI, R. J. Catalyst development for coal lique (EPRI-AF-1233)  BRRTRAND, R. R. Miniplant and bench studies of presentiation and bench studies of presentiation and bench studies of presentiation.	bybrid heating p0719 A80-44664 onents for p0723 A80-48186 - An assessment onshir p0689 A80-53682 oal wastes p0577 N80-28488 faction p0696 N80-29508 surized	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, F.  Analysis of the influence of geography on parabolic trough solar collector (SARD-79-2032)  BIKADI, L.  Conceptual design of RST: An rf-driven steady-state Tokamak (EPRI-AP-1351)  BILGER, G.  Integrated Cu2s-Cds thin film solar center of the collector of	sunshine 0625 A80-5168 and weather design 0631 N80-2887 n, 0751 N80-3223 11 generator 0606 A80-4677
BRRNABRI, S.  Transport code simulations of lower in tokamaks  BERRY, G. F.  Development of steam generator compopen-cycle MHD  BERRYNAM, M. S.  Tidal energy and the energy crisis of technology and the interrelati  BERTINO, J. P.  Trace element characterization of c [PB80-166150]  BERTOLACINI, R. J.  Catalyst development for coal lique [EPRI-AF-1233]  BERTRAND, E. R.  Miniplant and bench studies of pres fluidized-bed coal combustion [PB80-188121]	p0719 A80-44664 onents for p0723 A80-48186 - An assessment onshir p0689 A80-53682 oal wastes p0577 N80-28488 faction p0696 N80-29508	BIGA, A. J.  Estimating solar irradiation sums from and cloudiness observations  BIGGS, R.  Analysis of the influence of geography on parabolic trough solar collector (SAND-79-2032)  BIKADI, L.  Conceptual design of RST: An rf-driver steady-state Tokamak [EPRI-AP-1351]  BILGER, G.  Integrated Cu2S-CdS thin film solar certain collector (MAS 79-304)  BILLMAB, K.  SOLARES orbiting mirror system (AAS 79-304)  The OASIS computer program for optimization of integrated systems	sunshine 0625 A80-5168 and weather design 0631 N80-2887 n, 0751 N80-3223 11 generator 0606 A80-4677 0626 A80-5228 ation and
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p0735 A80-48763

BISHOP, W. S.
Analysis of small, nonconventional electric power BOHF, M. Performance characteristics of a commercially systems for remote site applications available, point-focus, solar power system p0765 A80-48272 p0629 A80-53570 Integrated solar receiver/biomass gasifier research [SERI/TP-333-507] p0630 N80-2856 BITTER. B. p0630 N80-28565 Experimental evidence of charge-exchange Analysis of the Omnium G receiver [SERI/TR-631-387] recombination of highly ionized iron and titanium in Princeton large torus p0637 N80-29872 p0735 A80-48765 BOHR, H. S. MCK, R. A. The Federal Geothermal Energy Program p0723 A80-48182 Thermoelectric OTEC - An update p0731 A80-48436 BOLAND. P. L. Nodal analysis of miniature cryogenic coolers Establishment of parameters for production of long life nickel oxide electrodes for nickel-hydrogen p0734 A80-48500 BOLT. J. A. Modifications for use of methanol or cells methanol-gasoline blends in automotive vehicles
[ALO-3682-T1] p0708 N80-32552 p0771 A80-48445 [ALO-3682-T1] BLINK, J. A. An engineering development plan for inertial confinement fusion BOLTON, J. R. Structures, reduction potentials and absorption maxima of synthetic dyes of interest in D0733 A80-48496 photochemical solar-energy storage studies The influence of grain size and dopant concentration on the electrical properties of p0595 A80-45314 polycrystalline silicon films Progress in the development of the thin film MIS solar cell based on CdSe D0600 A80-46696 BLOMEKE, J. O. Overview of nuclear fuel cycle [CONF-791185-3] p0603 A80-46728 Development of a cadmium selemide thin film solar p0698 N80-30171 cell [BEFT-FB-T-79-72] p0640 N80-29907 BLORQUIST, C. A. MQUIST, C. A.
Pulse combustion technology for heating applications
| INNL/RES/TH-85| p0707 N80-32467 BONONI, A. Fermentation ethanol as a petroleum substitute [ANL/EES/TM-85] BLOSS, P. B. p0675 A80-48324 Integrated Cu2s-Cds thin film solar cell generator p0606 A80-46770 BOOTH, L. A. Present and future status of thermochemical cycles Determination of the spectral distribution of applied to fusion energy sources global radiation with a rapid spectral radiometer and its correlation with solar cell p0663 A80-48450 BORDEN, P. G.
High-efficiency AlGals/Gals concentrator solar efficiency cells by organometallic wapor phase epitamy p0610 A80-46952 p0608 A80-46789 BLUM, D. BORDURE, G.
Model for the photovoltaic effect in Cu2S-Cds
solar cells in the backwall configuration
p0607 A8 Liquid-phase methanol [EPRI-AF-1291] p0692 N80-28567 BLURTON, K. P. Industrial energy conservation with the natural gas-fueled molten carbonate fuel cell p0607 A80-46775 BORES. K. L. Electric power generation using low temperature p0571 A80-48280 High-temperature water electrolysis for hydrogen geothermal resources and wood residues D0675 A80-48315 production p0662 A80-48414 BORST, W. L. BOBBETT, R. E. Measurement of natural convection in air-cooled Fuel cell systems for vehicular applications solar collectors [SAE PAREE 800059] p07
BOBROV, V. L.
End zone of a frame-type channel with an p0736 A80-49720 p0627 A80-52834 Navy-New Hampshire wind energy program [AD-A086506] p
BOTTRELL, G. P0701 N80-30904 inhomogeneous flow p0739 A80-52555 Development of a 4 kW wind turbine generator BODROV. I. S. A 150 MW power generating gas turbine plant p0719 A80-44773 p0725 A80-48269 Advanced synfuels production/power systems utilizing laser particulate control BOBCK, H.
Provision of electric power as a prerequisite and determining factor for safeguarding the industrial community and ensuring the economical development of the Third World p0710 N80-32570 [BNL-27783] BOURQUE, R. Conceptual design of RST: An rf-driven, steady-state Tokamak p0575 A80-50824 p0751 N80-32233 [ BPBI-AP-1351] BOUGHERSTER, R. J. B.
Sites for wind-power installations: Physical
modeling of the influence of hills, ridges and Key questions in the application of salt-stratified solar ponds p0617 A80-48364 complex terrain on wind speed and turbulence. Analysis of small, nonconventional electric power systems for remote site applications Part 1: Executi [RLO-2438-78/1] Executive summary p0706 N80-31900 p0765 A80-48272 Sites for wind-power installations: characteristics over ridges, part 2 BOGOMOLOV, E. N. On calculating gas turbine efficiency reduction under the influence of air cooling p0706 N80-31901 [RLO-2438-78/2] BOWER, C. T.

The thermodynamics of aqueous water electrolysis p0721 A80-47415 p0664 A80-50511 BOHABBON, M. L. The economic feasibility of passive solar space BOWNAN, M. G.
Hydrogen production from the solar based LASL heating systems p0627 A80-52832 cadmium cycle p0662 A80-48416 Recent developments in a slagging process for BOWMAN, R. M. conversion of refuse to energy Industrial energy conservation with the natural p0682 A80-49981 gas-fueled molten carbonate fuel cell

p0571 A80-48280

Righ-temperature water electrolysis for production	r hydrogen	BRAUN, B. Power generation from municipal and	industrial
P	0662 A80-48414	wastes with particular reference to	
Process evaluation: Steam reforming of	f diesel	combustion	
fuel oil		PARTY 6 P	p0685 A80-508
	0699 880-30538	BRAUH, G. W.  DOE solar thermal power systems progr	
BOWYER, J. M. Comparison of advanced engines for para	abolic dish	non sold thermal power systems prog-	p0629 A80-528
solar thermal power plants		BRAUF, K. A.	-
BOYCE, B.	0618 A80-48418	Static investigation of rotor blades under quasi-stationary loading	at rest and
Overview-absorption/Rankine solar cool:	ing program	[ISD-243]	£0747 N80-309
	0640 880-29904	Dynamic analysis of a rotor blade with	
BOYCE, T. A.		freedom, flapping freedom, and	•
Survey of world coal energy studies and	đ	variable-controlled blade pitch and	
international coal mining research	200 200 20551	[ISD-258]	p0747 N80-309
[PB-2468-68] p. BOYD, D. A.	0691 H80-28551	Production of light aromatics from co	nal hydrogenat
Density profiles in tokamaks from elec-	tron	reduced of right drouderes from ex	p0680 A80-496
cyclotron radiation spectra		BERITLING, W.	•
	0738 A80-51018	Study on the utilization of solar en	
Assessment of industrial energy conservations	vation by	operation of Spacelab material science	
unit processes [ORAU/IEA-80-4(M)]	0584 N80-31939	[DS-ERT-21-79] BREWER, G. D.	p0640 N80-303
BOYD, B.	0304 800 31333	Prospects for hydrogen aircraft	
The effect of demand uncertainty on the	e relative	[SAE PAPER 800756]	p0664 A80-497
economics of electrical generation to		BRIDGEATRE, A. V.	
with differing lead times		Chemical fuel and raw material produc	
BOSRK, J. H.	0570 A80-46336	thermal processing of refuse - Tech economics	потоду апа
Cycles till failure of silver-zinc cell	ls with	CCONDINICS	p0684 A80-500
competing failure modes - Preliminary		Refuse to fuels - An appraisal of the	
analysis	-	•	p0684 A80-500
	0761 A80-46414	BRIGGS, D. C.	.1
BOLLER, C. O. Efficient Gals shallow-homojunction so	lar cells on	Insat-I solar array - Design and deve	p0615 A80-482
single-crystal GaAs and Ge substrates		Electrical power subsystem for INSAT	
	0608 A80-46783	•	p0616 A80-483
B028UTO, C.		The Intelsat V nickel- cadmium batter	
Results from study of potential early of MHD power plants and from recent ETF		Nickel-hydrogen batteries for INTELS	p0769 <u>A80</u> -483
	0717 A80-44107	nioner ajarogen bacteries for raibbs	p0770 A80-484
BRACCO, P. V.	•	BRIGHT, R.	•
Formation and control of fuel-nitrogen		Electric utilities and residential so	
in catalytic combustion of coal-deriv		[BNL-27711]	p0638 880-298
[FE-2762-8] p(BRADKE, B. V.	0577 H80-28557	Selecting fines recycle methods to op	atimize fluid
Progress in the development of small fi	Lame heated	bed combustor performance	,
thermionic energy converters			p0671 A80-481
BRADLEY, S. P.	0732 180-48472	BRINEMANN, P. W.  Efficient thermal cycling of solar pa	nale in calar
Generalized performance predictions for	r energy	simulation facilities with a multi-	
conversion plants using geopressured			p0659 ¥80-338
fluids		BRITT, B. J.	
BRADLEY, T. G.	0725 A80-48268	Collector temperature effects on the of advanced thermionic converters	
Scaling up of bipolar lithium/iron dis	ulfide cells	electric propulsion systems	ing nectear
	0763 A80-48193		p0730 A80-484
BRAGAGNOLO, J. A.		Utilization of low temperature insula	itors and
Photon loss analysis and design of this	n-film	seals in thermionic converters	p0732 A80-484
planar junction Cu2S/CdS devices	0607 A80-46776	BROADBBUT, S.	D0125 800-404
BRAND, H. R.		470-k# photovoltaic power system for	Saudi Arabia
Use of an automated mass spectrometer i	foran	villages	
underground coal gasification field [UCRL-84366]	test 0709	BRODA, E.	p0616 A80-482
BRANDBORST, H. W.	0703 800-32303	Otilization of solar radiation for wa	ter photolysi
Photovoltaic technology development for	<b>r</b>		p0661 A80-476
synchronous orbit		BROBEL, J.	
	0657 N80-33470	Photovoltaic institutional issues st	udy p0584 ¥80-319
Radiation damage in high voltage silic	0658 N80-33889	[SAND-79-7054] BROOKS, H.	P0304 860-313
BRANDSTRITER, A.		The outlook for nuclear power	
Dimensionless groupings for photovolta	ic .	[PB80~175755]	p0579 N80-291
performance analysis	0620 180-51062	BROSSARD, I.	ac af .
BRANCT, D. L.	0624 A80-51463	Evaluation of cranking characteristic commercially available batteries be	
Refinery energy profile		temperature and '-40 C	
	0577 N80-28857	[AD-A080614]	p0780 N80-339
	0377 BG0-20037		
BRASIER, R. I.		BROTZES, F. R.	
BRASIER, R. I. Assessment of environmental control tec		BROTZEE, F. R. The photoklystron	p0623 ARO-509
BRASIER, R. I. Assessment of environmental control tec for energy storage systems, 1979			p0623 A80-509
BBASIER, R. I. Assessment of environmental control tec for energy storage systems, 1979 [LA-8308-MS]  BBATT, C.	chnologies 0568 x80-32973	The photoklystron  BROWALL, K. B.  Development of molten carbonate fuel	_
BBASIER, R. I.  Assessment of environmental control tec for energy storage systems, 1979  [LA-8308-MS]  BBATT, C.  Design characteristics and test results	chnologies 0568 x80-32973	The photoklystron  BROWALL, E. E.	cells for
BEASIER, R. I. Assessment of environmental control ter for energy storage systems, 1979 [LA-8308-MS]  BRATT, C. Design characteristics and test result: United Stirling F40 engine	chnologies 0568 x80-32973	The photoklystron  BROWALL, K. B.  Development of molten carbonate fuel	_

BROWN, C. E.	BURBRING, W.
Assessment of current research and development in	Methodology for the comparative assessment of the
support of the U.S. coal liquefaction	Satellite Power System (SPS) and alternative
demonstration plants program	technologies
p0677 A80-48428	[NASA-CR-163049] p0750 N80-31951
BROWN, D. H.	BURKRHS, A. G.
Cogeneration Technology Alternatives Study (CTAS).	Wood Waste gasification as a source of energy
Volume 2: Analytical approach	p0679 A80-49540
[NASA-CR-159766] p0741 N80-28859	BOHS, R.
Cogeneration Technology Alternatives Study (CTAS).	Progress in the field of terrestrial solar
Volume 4: Energy conversion systems	generators
[NASA-CR-159768] p0755 N80-33859	p0602 A80-46713
BROWN, D. R.	BOIST, B. J.
The economics of aquifer storage of chilled water	Universal thermoelectric design curves
for air conditioning	p0731 A80-48435
p0767 A80-48337	BUIVID, M. G.
BROWN, H.	Feasibility of a peat biogasification process
Environment: The energy connection	p0669 A80-46197
p0592 N80-33955	Status of peat biogasification development
BROWN, K.	p0674 A80-48293
Use of solar energy to produce process heat for	BUJOLD, H. P.
industry	Small passenger car transmission test; Chevrolet
[SERI/TP-731-626] p0651 N80-32863	LUV transmission
BROWN, L. P.	[NASA-CR-159882] p0584 N80-31796
Sorption of moisture and methane on Fruitland coal	BOLPITT, W. S.
PDOHN B A	Wood energy systems - An assessment
BROVE, R. A. Wickel-ging batteries for airgraft and acrosses	p0670 A80-47593
Nickel-zinc batteries for aircraft and aerospace	Economics of wood energy systems for industries
applications	p0673 A80-48275
p0772 180-48483	BURCH, J. B.
Pilot scale combustion evaluation of waste and	Pilot study to select candidates for energy.
alternate fuels, phase 3	Conservation research for the chemical industry
[PB80-177413] p0702 N80-30952	[DOE/TIC-11114] p0584 H80-31940
BROWN, W. A. N.	BURGESS, B. L.
The potential of energy farming for transport	Intermediate load-center photovoltaic application
fuels in New Zealand	erperiments
[PB80-154248] p0693 N80-28572	p0615 A80-48230
The potential of energy farming for transport	BURKE, J. R.
fuels in New Zealand, appendices [PB80-154255] p0693 N80-28573	Research issues for low cost photovoltaic cells
	p0605 A80-46748
BRUCK, M.	BURKE, W. B.
Regenerative energy sources for the production of	Photovoltaic generators in space
low temperature heat: Energy sources, energy	[ESA-SP-147] p0658 N80-33873
types, and energy conversion; results and	BURNEISTER, L. C.
applications; measures to promote use	Spectral effects on direct-insolation absorptance
[ISBN-3-7041-0038-2] p0702 N80-30951	of five collector coatings
BRUCKNER, A. P.	[ASHE PAPER 79-HT-18] p0597 A80-45722
A new method of efficient heat transfer and	BURNET, G.
storage at very high temperatures	Processes to increase utilization of power solid
BRUMBERG, R. J.	wastes [ISM-245] p0702 N80-30929
Feasibility study: Fuel cell cogeneration in a	[ISM-245] p0702 N80-30929 BURNS, H. L.
water pollution control facility, volume 1	Energy choices and environmental constraints
[DOE/ET-12431/T1-VOL-1] p0749 880-31922	p0576 A80-51933
BRUNG, C.	BURRELL, K. H.
Formation and control of fuel-nitrogen pollutants	Alteration of Pfirsch-Schlueter transport in
in catalytic combustion of coal-derived gases	tokamaks by all four external sources
[PE-2762-8] p0577 N80-28557	p0735 A80-49058
BRUZZONE, C.	BURROWS, B. W.
Photocell heat engine solar power systems	Low maintenance lead-acid batteries for energy
p0612 A80-48179	storage -
High-temperature fusion blanket for a synthetic	p0765 A80-48326
fuel plant	BURTON, L. C.
p0663 A80-48451	CdSiAs2 thin films for solar cell applications
BROZZONE, G.	[DOE/ET-23007/1] p0653 N80-32919
Hydrogen storage in a beryllium substituted TiFe	BUSCH, C. P.
. compound	Pilot scale combustion evaluation of waste and
p0661 A80-45060	alternate fuels, phase 3
BRYANT, N. A.	[PB80-177413] p0702 N80-30952
Urban solar photovoltaics potential: An inventory	BUSHNELL, C. L.
and modelling study applied to the San Pernando	Advanced technology fuel cell program
Valley region of Los Angeles	[EPRI-EM-1328] p0752 N80-32877
[NASA-CR-163436] p0636 N80-29859	BUSICO, V.
BRYART, N. A.	The layer perovskites as thermal energy storage
Performance and structural characteristics of the	systems
iron-air battery system	p0761 A80-45315
p0767 A80-48371	The development of thermal energy storage systems
BOBE, R. H.	exploiting solid-solid phase transitions
Oxide/semiconductor photovoltaic heterojunctions	g0774 A80-50970
based on CdTe or InP	BUSWELL, R. P.
p0603 A80-46732	Advanced technology fuel cell program
BUCKLAND, B. O.	[EPRI-EM-1328] p0752 N80-32877
Worldwide survey of current experience burning	BOTCHER, T.
residual and crude oils in gas turbines	Soot reduction in diesel engines by catalytic
[EPRI-AF-1243] p0693 N80-28724	effects
BUDERHOLZER, R. A.	[ D D T _ 2770 2 ]
	[BNL-27792] p0585 N80-32731
Navy-New Hampshire wind energy program [AD-A086506] p0701 N80-30904	[ BRL-27792 ] pu303 800-32731

p0608 A80-46790

BÜZBY, J. H.		CAMPBELL, P. P.	
Hydrogen production by photoelectro		Current jet fuel trends	
decomposition of H2O using solar (NASA-CR-163586)	energy p0667 #80-32854	CAMPBELL, S.	p0694 N80-29303
Performance and structural character	cistics of the	Heat storage utilizing Thermol 81 Er	p0762 A80-47598
iron-air battery system	p0767 A80-48371	CANOS, R. H.  Removal of metals from coal ash	
C	port. 200 10011	•	p0674 A80-48295
C		CAPE, J. A.	J
CABBAL, J. A.		20 kW gallium arsenide photovoltaic for central receiver concentrator	applications
Study of gelled LBG [DOE/EV-02057/T2]	p0695 B80-29506	Gallium arsenide photovoltaic dense	p0608 A80-46793 array for
CADOFF, L. fl.  HHD electrode development	p0748 N80-31222	concentrator applications [SAND-80-1569C] Gallium arsenide photovoltaic dense	p0654 N80-32936
[PE-15529-5] CADOTTE, A. P. The Wetox process for energy recover		concentrator applications [SAND-79-2270C]	p0655 #80-32938
sludge and industrial waste stream	ns .	CARBORELLE, G.	•
CABILL, L. B.	P0683 A80-49998	Study of a hydro-photovoltaic plant generation in central and northern	
Energy choices and environmental con	p0576 A80-51933	countries	p0605 A80-46746
CAHW, D. F. Haterial-flow data structures as a	basis for	CARD, E. E. Outlook for alternative energy source	
energy information system design [LBL-10248]	p0760 N80-31923	CARDOS, F.	p0694 #80-29302
CAILLAT, JB.	•	On the influence of an interfacial of	
The effect of direct and diffuse rac thermal performance of flat-plate		Au/n-Gals Schottky barrier solar o	;ells p0608 180-46784
• •	p0620 A80-48793	CAMPAGNA, C. The layer perovskites as thermal end	ran eterade
CAIRES, B. R.  High-efficiency AlGals/Gals concent:	rator solar	systems	styl storage
cells by organometallic vapor phase	se epitaxy p0610 A80-46952	CARLSON, D. R.	p0761 A80~45315
CALAMB, R. The functional use of the heat generation	· .	The stability of amorphous silicon Schottky-barrier solar cells	•
refuse incineration plant as exem			p0602 A80-46722
RIP Hamburg Stapelfeld CALHOUR, J. T.	p0681 A80-49962	Amorphous thin films for solar-cell [DOE/ET-21074/4] CABLSON, D. E.	applications p0653 B80-32921
Peasibility studies of spoiler and systems for large horizontal-axis	wind turbines	Development status and utility of the acid chemical beat pump/chemical e	
CALL, P. J.	p0727 A80-48318	system	p0765 A80~48288
Summary of Solar Experience with the Optical Surfaces		Chemical energy storage for solar the [SAND-79-8198]	p0652 #80-32889
[SERI/TP-334-478] CALLABAB. S. F.	p0639 N80-29894	CARLSON, P. K. Assessment of current research and	development in
Selecting fines recycle methods to bed combustor performance	optimize fluid	support of the U.S. coal liquefact demonstration plants program	tion
_	p0671 A80-48169	•	p0677 A80-48428.
CALLEN, R. B.  Upgrading of coal liquids for use as generation fuels	e boast	CARLSOB, B. D. Navy-New Hampshire wind energy progr [AD-A086506]	ram p0701 H80-30904
[EPRI-AF-1225] CALB, J. B.	p0699 x80-30547	CARLSSOW, I. Safety of wind energy conversion sys	-
The OASIS computer program for optimisimulation of integrated systems		Freliminary study [FFA-HU-2126]	p0742 N80-28933
Heat-pump-centered integrated commun	p0571 A80-48333	CARPENTER, H. J.  Perspectives on research on LNG vapo	or cloud
systems: System development summa		dispersion	p0590 N80-33593
[ANL/CHSV-7]	p0376 860-26663	CABPBTIS, C.	
SPOT solar array	p0658 N80-33880	A system consideration of altèrnation storage facilities for estimation	of storage costs
CALZOLARI, P. U.  Numerical modelling of a solar cell	in three	CARR, N. J.	p0661 180-47666
dimensions	p0605 A80-46749	Altos-model 8B wind turbine generate analysis [RPP-3035/3533/79-10]	p0742 N80-28925
CAMARA, E. H. Process evaluation: Steam reforming	g of diesel	CARRIERE, W. M.	-
fuel oil [AD-A087053]	p0699 #80-30538	Impact of electric cars on 0.5. pet	
CAMBRL, A. B. Second law analysis of energy device		[SAE PAPER 800108] CARRIEGTON, R. A.	p0773 A80-49726
processes; Proceedings of the World Washington University, Washington		Component Development and Integration description and status report	_
14-16, 1979	p0576 A80-51202	CARROLL, B.	p0723 A80-48187
CAMP, D. W. A water-influx model for UCG with	-	Human comfort and auxiliary control in passive solar structures	
spalling-enhanced drying	p0676 A80-48343	[LBL-10034] CARROLL, W. P.	F0640 N80-29903
CAMPBELL, J. H. Solar coal gasification		Physical/chemical modeling for photo life prediction	voltaic module
•	n0616 180-08203	• ***	20608 180-06700

p0616 A80-48243

PERSONAL AUTHOR INDEX CHELEN, E. J.

Results from the Hoe Creek No. 3 underground coal CARSON, L. K.
Study of methane fuel for subsonic transport gasification experiment aircraft LLL in situ coal gasification project [UCRL-50026-79-4] p0705 N80-: CBRIBI, D. J. Power production from geothermal brine with the [ NA SA-CR- 159320 ] p0708 N80-32533 CARSON, S. R.
Assessment of Synthane mechanical equipment p0705 N80-31654 [BTI-79TR5] p0710 N80-32572 CART, R. B., JR. rotary separator turbine Comparison of alternate aviation fuels
[SAE PAPER 800767] p0725 A80-48266 P0680 A80-49711 CERRAK, J. S. Hean wind forces on parabolic-trough solar CARTER, C. collectors
[SAND-80-7023] Predicting passive solar performance using modal p0650 N80-32790 expansions CHADENET, B.
Financing of energy investments - Capital and p0627 A80-52836 CARTER, W. D. Remote sensing and mineral exploration; Proceedings of the Workshop, Bangalore, India, May 29-June 9, 1979 policy requirements of developing countries p0573 A80-49395 CHADWICK, D. G. Design of a cost effective solar powered water pump [FB80-182819] p0649 N80-31967 CHAGHOT, B. J. p0686 A80-51076 CARVALEO, A. V., JB.
Fermentation ethanol as a petroleum substitute p0675 A80-48324 Stirling engines for developing countries p0732 A80-48454 CASAVANT, D. Assessment of industrial energy conservation by CHAI, A.-T. unit processes [ORAU/IEA-80-4(M)] The planar multijunction cell - A new solar cell p0584 N80-31939 for earth and space CASKEY, D. L.
Sandia battery program for energy storage in photovoltaic systems D0613 A80-48205 CHAMBERLAIN, R. G. Recent developments in the economic modeling of p0767 A80-48368 photovoltaic module manufacturing CASPERD, A. N.
The spectral response of CdS:Cu/x/S solar cells D0607 A80-46773 CHAMPION, B. L. formed by dry barrier techniques Line-focus solar thermal energy technology development. Report for Department 4720 [SAND-80-0865-REV] p0651 p0597 A80-46251 CASPERSON, R. L.
Experimental investigation of the Trombe wall p0651 N80-32887 CHAN, M. S. Structures, reduction potentials and absorption maxima of synthetic dyes of interest in passive solar energy system P0627 A80-52833 CASSANO, A. A.
Cryogenic methane separation/catalytic photochemical solar-energy storage studies p0595 A80-45314 CHANCE, M. S.
Absolute dissipative drift-wave instabilities in hydrogasification process analysis [PE-3044-T6] p0690 N80-28548 CASTLE. J. tokamaks A review of collector and energy storage p0719 A80-44663 CHANDRA, A. Cathode sheaths in potassium seeded MHD combustion technology for intermediate temperature applications p0595 A80-45311 plasmas CATHALA, H. SPOT solar array p0720 A80-46158 CHANDRA, S. p0658 N80-33880 Solar energy conversion using CdSe photoelectrochemical cells with low cost CAVAGEARO, D. M.
Hydrogen production. Citations from the ETIS data substrates p0597 A80-46253 [PB80-810476] p0665 N80-29519 CHANG, C. T.

The feasibility of pellet re-fuelling of a fusion Hydrogen storage: Hydrogen as a hydride. Citations from the NTIS data base reactor [PB80-811094] Alcohol fuels. C: Index data base p0665 N80-30561 D0719 A80-44661 Citations from the Engineering CHANG, G. C. Performance and applications potential of a [PB80-812449] p0711 N80-32581 turbine-pump with controlled flow rate Alcohol fuels. Ci Index data base Citations from the Engineering p0768 A80-48375 CHANG. R. P. H. Parametric decay into ion cyclotron waves and drift waves in multi-ion species plasma [PB80-812456] p0711 N80-32582 Lithium batteries. Citations from the NIIS data p0735 A80-49071 base Parametric excitation of ion quasi-mode by the [ PB80-812399] p0779 N80-32967 pump near the ion cyclotron frequency Lithium batteries. Citations from the Engineering Index data base p0736 A80-49072 [PB80-812407] p0779 N80-32968 Citations from the NTIS data base CHAPTAK, R. J.
Perspectives on research on LNG vapor cloud Lead tatteries. p0780 N80-33923 [PB80-813363] dispersion Lead batteries. Citations from the Engineering p0590 N80-33593 Index data base [PB80-813371] CHARTIER, P. p0780 N80-33924 European Community's biomass programme CEASE, M. E. D0687 A80-52859 A model direct contact heat transfer for latent The mist-lift OTEC cycle heat energy storage p0765 A80-48241 p0718 A80-44602 Model of direct contact heat transfer for latent CHAUHAN, S. P. heat energy storage [SERI/TP-631-567] Thermophysical properties of coal liquids p0701 N80-30557 p0779 N80-32955 [BHI-2043] CHEEK, G.
MIS and SIS solar cells on polycrystalline silicon
p0597 A80-46257 CRMBALI, F.

Effect of laser irradiation on the characteristics of implanted layers for silicon solar cells p0602 A80-46711 CHELEN. E. J. Advanced coal gasification system for electric power generation [PE-1514-97] Highlights of the LLL Hoe Creek No. 3 underground p0700 N80-30548 coal gasification experiment

pQ670 A80-46606

CERH, C. L.	CHIANG, C. R.
Past fluid hed coal gasification in a process	
development unit	[PB80-182355] p0748 N80-309
p0672 A8	
CHEE, F. C. Thermally driven open-cycle heat pump system	Hydrogen distribution and transfer in coal
[CONF-800549-1] p0582 N8	hydrogenation systems 0-30938 [DOE/PC-30014/1] p0758 N80-294
CBRH, H. C.	CHIBA, T.
Refining and apprading of synfuels from coal	
oil shales by advanced catalytic processes.	reaction models of coal hydrogenation
Laboratory and pilot plant studies of the	p0679 A80-496
processing of SRC-1	CHIBN. H. C.
[FE-2315-45] p0699 H8	0-30544 Sites for wind-power installations: Physical
CHEN, H. T.	modeling of the influence of hills, ridges and
Research and evaluation of biomass	complex terrain on wind speed and turbulence.
resources/conversion/utilization systems	Part 1: Executive summary
(market/experimental analysis for developme	
a data base for a fuels from biomass model)	
[DOE/RT-20611/11] p0700 N8	0-30552 Heat loss and storage functions for a thermal well p0596 180-453
New method to determine the independent shear	
moduli of transversely isotropic materials	Appraisal of the M factor and the role of building
[CONF-800575-1] p0712 N8	
CHEN, L.	[OBNL/CON-46] p0588 N80-329
Absolute dissipative drift-wave instabilities	in CHILDESKAS, A. A.
tokamaks	Recent progress in lithium/iron sulfide battery
p0719 A8	
CHEN, W.	p0762 A80-481
Conceptual design of RST: An rf-driven,	CHILLINGWORTH, R. S.
steady-state Tokamak [EPBI-AP-1351] p0751 N8	LC-Fining of solvent refined coal - SRC-I and
CHEN, N. S.	0-32233 short contact time coal extracts p0678 A80-484
Emerging materials systems for solar cell	CHIM, B. L.
applications: Cu/sub 2-x/Se	Research on Cu sub x S/(cd, Zn)S photovoltaic
[DOE/RT-23005/T3] p0632 N8	
CHEH, Y. C.	[LBL-10791] p0654 N80-329
Research and evaluation of biomass	CHIOU, B.
resources/conversion/utilization systems	Power extraction from deep ocean waves employing a
(market/experimental analysis for developme	
a data base for a fuels from biomass model)	[ASME PAPER 80-PET-29] p0720 A80-452
[DOE/ET-20611/11] p0700 N8	
CHENEVAS-PAULE, A- Schottky barriers on sputtered hydrogenated	p0728 A80-483
amorphous silicon - Photovoltaic properties	
capacitance-voltage characteristics	defects and I-V characteristics of 200 keV
p0602 A8	
CHENEY, M. C.	p0613 A80-482
UTRC 8 kW wind turbine tests	CHO, B. S.
[RFP-3085] p0752 N8	
Development of an 8 kW wind turbine generator	
residential type application. Phase 1: De	
and analysis. Volume 1: Executive summary	
[DOE/DP-03533/T1-VOL-1] p0753 N8 CHENG, C. 2.	0-32957 CHONG, K. P.  New method to determine the independent shear
Absolute dissipative drift-wave instabilities	
tokamaks	[CONF-800575-1] p0712 N80-327
p0719 A8	
CHENG, B. T.	Human comfort and auxiliary control considerations
High-temperature thermochemical water splitti	
cycle fusion reactor design considerations	[LBL-10034] p0640 N80-299
. p0663 A8	
CHENG, W.	Solar energy for buildings handbook
Characterization of open-cycle, coal-fired MH	
generators [ARI-RP-43] p0750 N8	CHRISTIAN, J. B. Development of an energy genevation and goet date
[ARI-RP-43] p0750 N8 Characterization of open-cycle, coal-fired MH	0-31936 Development of an energy consumption and cost data D base for fuel cell total energy systems and
qenerators	conventional building energy systems
[ARI-RP-46] p0751 M8	
CHERISH, P.	CHRISTIANSEN, W.
Advanced coal gasification system for electri	
power generation	p0612 A80-481
[FB-1514-97] p0700 N8	
CHERT, S. S.	The long-term effects of trace elements emitted by
Induced junction solar cell and method of	energy conversion of lignite coal
fabrication [NASA-CASE-NPO-13786-1] p0634 N8	[PB80-168867] p0578 M80-2899 0-29835 The long-term effects of trace elements emitted by
CHERRY, W. H.	energy conversion of lightee coal. Volume 2:
Investigation of fuels containing coal-oil-wa	
emulsions fire tube test apparatus	[PB80-168875] p0579 880-2890
[DOB/ET-10634/T1] p0691 N8	
CHEVALIER, Y.	Conceptual design of RST: An rf-driven,
Advances in theory, fabrication and applicati	ons steady-state Tokamak
of bifacial solar cells	[EPRI-AP-1351] p0751 N80-322
p0606 A8	
CHI, J. I.	A study on utilizing solar energy for hydrogen
A multiple p-n junction structure obtained fr	
as-grown Czochralski silicon crystals by he treatment - Application to solar cells	p0665 A80-535
p0595 A8	0-45121

CHUBB, T. A.  Bnergy storage as heat-of-fusion in containerized  salts. Beport on energy storage boiler tank	CLUGSTON, J. P. Proceedings of the Clemson Workshop on Environmental Impacts of Pumped Storage
[AD-A087753] p0777 #80-32862	Hydroelectric Operations
CHUDACEK, R. C. Status of electrochemical energy storage systems for electric vehicle, solar, and electric	[FB80-192453] p0588 M80-32964 COBBLE, B. H. Cassegrain solar concentrators for photovoltaics
utility applications	p0608 180-46791
P0765 180-48325	COCKFIELD, B. D.  RTG power source for the International Solar Polar
Analysis of the application of thermogalvanic cells to the conversion of low grade heat to	Mission p0727 180-48305
electricity p0729 A80-48390	COB, W. D., JR. MHD electrode development
CHURCHILL, T. L. TRACT -A small fusion reactor based on near-term	[FE-15529-5] p0748 N80-31222 COMBN-SOLAL, G.
engineering p0733 A80-48493	CdTe homojunctions solar cells p0603 180-46731
CHINOUETH, D. P.  Kelp processing and biomethanation technology	COMEN, D. Liquid-metal MBD for solar and coal - System and
p0673 A80-48278	component status p0724 180-48226
Ocean thermal energy conversion /OTEC/ - A subscale test range	COHEN, B. B. Energy from MSW - The industrial market
p0740 A80-53674 CIRILLO, R.	p0670 A80-47588
Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies	Materials for fuel cells [PB80-182355] p0748 N80-30955 COHEN, S. N.
[DOE/ER-0055]  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative	Fuels research: Fuel thermal stability overview p0694 N80-29324
technologies [NASA-CR-163049] p0750 N80-31951	Organic material emissions from holding ponds at coal-fired power generation facilities
CIRILIO, R. R.	[EPRI-EA-1377] p0589 N80-32987
Comparative analysis of met energy balance for Satellite Power Systems (SPS) and other energy	COLE, D. E. Modifications for use of methanol or
systems [DOE/ER-0056] p0582 N80-30916 CLARCO, V.	methanol-gasoline blends in automotive vehicles [ALO-3682-T1] p0708 M80-32552 COLELLO, R. G.
Investing in coal p0572 A80-49391	Potential of spark ignition engine, effect of vehicle design variables on top speed,
CLAHDY, J.  Research needs for coal gasification and coal	performance, and fuel economy [PB80-191836] p0586 N80-32736
liquefaction p0688 A80-53274	COLEMAN, W. A. Westinghouse OTEC power systems
CLARE, B. C. Development status and utility of the sulfuric	p0718 A80-44601
acid chemical heat pump/chemical energy storage system p0765 180-48288	The fate and effects of crude oil spilled on subarctic permafrost terrain in interior Alaska [PB80-187305] p0585 N80-31984
Sulfuric acid and water chemical heat	COLLIES, J. H.
pump/chemical energy storage program, phase 2-A [SAND-78-8176] p0776 N80-30924 CLARK, R. P.	Efficiency of quantum-utilizing solar energy converters in the presence of recombination losses p0610 A80-46953
Sandia battery program for energy storage in photovoltaic systems	COLLINS, H. M. Impact of electric cars on U.S. petroleum
p0767 A80-48368	consumption [SAE PAPEE 800108] p0773 A80-49726
Investigation of a Philips MP 1002 CA Stirling engine	COLLINS, P. Q. Peasibility of siting SFS rectennas over the sea
P0734 A80-48499	p0623 A80-50955
The potential global market in 2025 for Satellite Solar Power Stations	Use of gas from landfills for energy recovery - Operating experience at Palos Verdes
p0598 A80-46382	p0683 A80-49999
Energy economic projections for the 1979 overview [EPRI-PS-79-5-LD] p0578 N80-28918 CLELAND, J. G.	Magma energy: A feasible alternative [SAND-80-0309] p0693 880-28874 COLSON, W. B.
Pollutants from synthetic fuels production: Coal	The photoklystron
gasification screening test results [PB80-182769] p0707 N80-31986 CLINCH, J. H.	p0623 A80-50956 COLUSEA, C. n-CdS/p-Si heterojunction solar cells
Pulse combustion technology for heating applications [ANL/EES/TH-85] p0707 N80-32467	p0626 A80-52498
CLINTON, J. H.	H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal
Selectivity improvement in the solvent refined coal process. I - Detailed first-stage reaction	p0677 A80-48429
studies - Coal mineral catalysis. II - Detailed second-stage reaction studies - Hydrotreating of	COMPARD, D. Aerospace_technology_transfer
coal liquids p0679 A80-49630	[SNIAS-792-422-112] p0579 N80-29210 Example of a policy aimed at increasing the value
CLOYD, J. S. Bickel-zinc batteries for aircraft and aerospace	of spin-offs from space technology in other fields [SNIAS-801-422-101] p0782 N80-32297
applications p0772 &80-48483	Thermal stress in a composite cylinder by finite difference technique
	[ASME PAPER 80-HT-107] p0612 A80-48036

COHDAP, R. J. Harket penetration of energy supply technologies	CON, C. H., III Residential photovoltaic systems costs
p0579 H80-29837	p0615 180-48229
Turbulence as experienced by a moving rotor of a wind turbine	COI, K. E.  Present and future status of thermochemical cycles applied to fusion energy sources
p0727 A80-48320	p0663 A80-48450
Definition of gust model concept and review of gust models	A comparison of capital cost estimates and process efficiencies for hydrogen production by
[PNL-3138] p0712 N80-33072	thermochemical cycles and water electrolysis
Wind characteristics program element [PNL-3211] p0754 N80-33073	COYLE, R. T.
COMPOLLY, J. N.	Properties of a solar alumina-borosilicate sheet
Performance of storage walls with highly conductive covering plates and connecting fins	glass [SERI/TP-334-565] p0641 H80-30530
[ASME PAPER 80-HI-18] p0762 A80-48009	CHARTERE, W. L.
Performance of storage walls with highly conductive covering plates and connecting films	Solar thermophotovoltaic space power system p0614 A80-48208
[SERI/TP-721-574] P0779 N80-32548	Large solar arrays
Computer modeling of thermal storage walls [SERI/TP-721-610] p0779 N80-32949	p0657 H80-33471 CRAIG, B. B.
COHOVER, R. C.	Environmental constraints on geothermal energy
Vehicles testing of near-term batteries [SAE PAPER 800201] p0773 A80-49730	[ORNL-1310] p0580 N80-29868 CRAHDALL, R. S.
CONTI, H.	Amorphous thin films for solar-cell applications
High efficiency silicon solar cell for concentrator systems	[DOE/ET-21074/4] p0653 N80-32921 CRAWPORD, R. W.
p0606 A80-46767	Use of an automated mass spectrometer for an
CONVAY, E. J. Gals solar cells for space applications	underground coal gasification field test [UCBL-84366] p0709 N80-32565
p0613 A80-48203	CREMER, G.
COOKE, D. L. Environmental protection of the solar power	Alternative Gas Workshop [LA-8155-C] p0690 N80-28547
satellite	CRETER, C.
p0609 A80-46899 A computer model of solar panel-plasma interactions	Electrochemical photovoltaic cells cdSe thin film electrodes
[NASA-CR-160796] p0650 N80-32853	[DSE-4042-T16] p0654 N80-32925
COOLEY, C. H. Temperature-induced permeability alterations in	CRISP, J. B. Transient thermal analysis of phase change thermal
unconsolidated and consolidated aguifer media	energy storage systems
p0766 A80-48336	[ASHE PAPER 80-HT-2] p0762 A80-48001 Analysis of small, nonconventional electric power
Biomass - Puture developments	systems for remote site applications
p0687 A80-52858	p0765 A80-48272
COOPER, C. B., III	CRISWELL, D. R.
High-efficiency AlGaAs/GaAs concentrator solar	Scaling and the start-up phase of space
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy p0610 A80-46952	Scaling and the start-up phase of space industrialization p0598 A80-46386
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy p0610 A80-46952 COOPER, J. P.	Scaling and the start-up phase of space industrialization p0598 A80-46386 CROMACK, D. E.
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy p0610 A80-46952 COOPER, J. F. The aluminum-air battery for electric vehicle propulsion	Scaling and the start-up phase of space industrialization p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy p0610 A80-46952  COOPER, J. P.  The aluminum-air battery for electric vehicle propulsion p0768 A80-48373	Scaling and the start-up phase of space industrialization p0598 A80-46386  CROMACE, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOE/DP-03533/T3] p0753 N80-32950
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  p0779 N80-32341	Scaling and the start-up phase of space industrialization p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOE/DP-03533/T3] p0753 N80-32950  CROMAURE, D. C.  Investigation of mechanisms of hydrogen transfer
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy p0610 A80-46952  COOPER, J. P. The aluminum-air battery for electric vehicle propulsion p0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443] p0779 N80-32941  COPELAND, R. J.	Scaling and the start-up phase of space industrialization p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80-32950  CROMADER, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  Aluminum air battery for electric vehicle propulsion [UCNL-84443]  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels	Scaling and the start-up phase of space industrialization p0598 A80-46386  CEOMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80-32950  CEOMAUBE, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. P.  The aluminum-air battery for electric vehicle profulsion p0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443] p0779 N80-32941  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3] p0630 N80-28569	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOE/DP-03533/T3] p0753 N80-32950  CROMADER, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  p0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  p0779 N80-32941  COPELAND, E. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, E. B.  Hilitary jet fuel from shale oil	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CEOMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3]  CROWAUBR, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33]  Investigation of mechanisms of hydrogen transfer in coal hydrogenation of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30]  CROWLEY, J. B.
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. P.  The aluminum-air battery for electric vehicle profulsion  [UCRL-84443]  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, R. N.  Military jet fuel from shale oil	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80-32950  CROWADER, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2  [FE-2305-30] p0710 N80-32568  CROWLEY, J. B.  Satellite Power Systems (SPS) cost review
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  p0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  p0779 N80-32941  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, B. B.  Hilitary jet fuel from shale oil  CORBETT, R. B.  High voltage power systems for military needs	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. R.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80-32950  CROWAUBR, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 N80-32568  CROWLEY, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p0654 N80-32928  CRUM, B. M.
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. P.  The aluminum-air battery for electric vehicle profulsion  p0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  COPELAND, B. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, B. N.  Military jet fuel from shale oil  p0694 N80-29308  CORBETT, R. E.  High voltage power systems for military needs p0725 A80-48254	Scaling and the start-up phase of space industrialization  p0598 & 80-46386  CROMACK, D. E.  Investigation of the feasibility of using wind power for space heating in colder climates [DOE/DP-03533/T3] p0753 N80-32950  CROWADER, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 N80-32568  CROWLEY, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p0654 N80-32928
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  p0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  p0779 N80-32941  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, B. B.  Hilitary jet fuel from shale oil  CORBETT, R. E.  High voltage power systems for military needs p0725 A80-48254  CORLETT, B. C.  Theory of reverse combustion along fissures in	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CEOMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates  [DOB/DP-03533/T3]  CROWAUBR, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation  [FE-2305-33]  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2  [FE-2305-30]  CROWLER, J. H.  Satellite Power Systems (SPS) cost review  [DOE/TIC-11190]  CRUM, B. M.  Electric propulsion for SPS  P0643 N80-31466  CRIMES, B. L.
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitaxy p0610 A80-46952  COOPER, J. P. p0610 A80-46952  The aluminum-air battery for electric vehicle propulsion p0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443] p0779 N80-32941  COPELAND, R. J. conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3] p0630 N80-28569  COPPOLA, B. B. Hilitary jet fuel from shale oil p0694 N80-29308  CORBETT, R. B. High voltage power systems for military needs p0725 A80-48254	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates  [DOE/DP-03533/T3] p0753 N80-32950  CROMADER, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation  [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2  [FE-2305-30] p0710 N80-32568  CROWLEY, J. H.  Satellite Power Systems (SPS) cost review  [DOE/TIC-11190] p0654 N80-32928  CRUM, B. N.  Electric propulsion for SPS
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  P0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  P0779 N80-32941  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, B. B.  Hilitary jet fuel from shale oil  CORDETT, R. E.  High voltage power systems for military needs p0725 A80-48254  CORLETT, B. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  CORDEAS, A.	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CEOMACK, D. E.  Investigation of the feasibility of using wind power for space heating in colder climates  [DOE/DP-03533/T3]  CROWAUBR, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation  [FE-2305-33]  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2  [FE-2305-30]  CROWLEK, J. H.  Satellite Power Systems (SPS) cost review  [DOE/TIC-11190]  CRUM, E. M.  Electric propulsion for SPS  CRIMES, B. L.  Catalysts for upgrading coal-derived liquids  [DOE/ET-14876/2]  CSOMOR, A.
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPBB, J. F.  The aluminum-air battery for electric vehicle propulsion  Aluminum air battery for electric vehicle propulsion [UCRL-84443] p0779 N80-32941  COPBLAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3] p0630 N80-28569  COPPOLA, B. B.  Military jet fuel from shale oil  CORBETT, R. R.  High voltage power systems for military needs p0725 A80-48254  CORLETT, B. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROHAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates  [DOE/DP-03533/T3] p0753 N80-32950  CROMADER, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation  [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2  [FE-2305-30] p0710 N80-32568  CROWLEY, J. H.  Satellite Power Systems (SPS) cost review  [DOE/TIC-11190] p0654 N80-32928  CRUM, B. N.  Electric propulsion for SPS  CATALYSTS B. L.  Catalysts for upgrading coal-derived liquids  [DOE/ET-14876/2] p0691 N80-28556
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  COPELAND, R. J.  CONVERSION System overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, B. B.  Hilitary jet fuel from shale oil  CORDETT, R. B.  High voltage power systems for military needs p0725 A80-48254  CORLETT, B. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROBAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CEOMACK, D. E.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3]  CROWAUBR, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33]  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30]  CROWLEK, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190]  CROWLEK, B. M.  Electric propulsion for SPS  CRIMES, B. L.  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  CSOMOB, A.  The new age of high performance kinetic energy storage systems
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. P.  The aluminum-air battery for electric vehicle profulsion p0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443] p0779 N80-32941  COPELAHD, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels (SERI/TR-35-078-VOL-3) p0630 N80-28569  COPPOLA, R. B.  Military jet fuel from shale oil  CORBETT, R. E.  High voltage power systems for military needs p0725 A80-48254  CORLETT, B. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  CORDHAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain p0625 A80-51684  COSTA, G.  Hydrogen storage in a beryllium substituted Tife	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOE/DP-03533/T3] p0753 N80-32950  CROMADER, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 N80-32568  CROWLEY, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p0654 N80-32928  CRUM, B. M.  Electric propulsion for SPS  CRIMES, B. L.  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2] p0691 N80-28556  CROMOR, A.  The new age of high performance kinetic energy storage systems p0768 N80-48374  CUEVAS, A.  High efficiency transcells and vertical
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  P0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  P0779 N80-32941  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, B. B.  Hilitary jet fuel from shale oil  CORDETT, R. E.  High voltage power systems for military needs p0725 A80-48254  CORLETT, B. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROHAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain  P0625 A80-51684  COSTA, G.  Hydrogen storage in a beryllium substituted TiPe compound	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CEOMACK, D. R.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3]  CROWAUBR, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33]  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30]  CROWLER, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190]  CRUMER, B. M.  Electric propulsion for SPS  CRIMES, B. L.  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2]  CSOMOB, A.  The new age of high performance kinetic energy storage systems  P0768 A80-48374  CUEVAS, A.  High efficiency transcells and vertical multijunction cells for double-sided
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPBB, J. F.  The aluminum-air battery for electric vehicle propulsion  Aluminum air battery for electric vehicle propulsion [UCRL-84443] p0779 N80-32941  COPELABD, R. J.  Conversion system overview assessment. Volume 3:     Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3] p0630 N80-28569  COPPOLA, B. B.  Hilitary jet fuel from shale oil  CORBETT, R. E.  High voltage power systems for military needs p0725 A80-48254  COELBIT, B. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROHAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain  p0625 A80-51684  COSTA, G.  Hydrogen storage in a beryllium substituted TiPe compound  p0661 A80-45060	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CEOMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOE/PP-03533/T3] p0753 N80-32950  CEOMAURE, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 N80-32568  CEOWLEY, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p0654 N80-32928  CEUM, B. M.  Electric propulsion for SPS  CALLYSTS for upgrading coal-derived liquids [DOE/ET-14876/2] p0691 N80-28556  CSOMOR, A.  The new age of high performance kinetic energy storage systems p0768 A80-48374  CUEVAS, A.  High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination p0606 A80-46768
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. P.  The aluminum-air battery for electric vehicle profulsion  P0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, R. B.  Hilitary jet fuel from shale oil  CORDETT, R. E.  High voltage power systems for military needs p0725 A80-48254  CORLETT, R. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROFAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain  P0625 A80-51684  COSTA, G.  Hydrogen storage in a beryllium substituted TiFe compound	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CEOMACK, D. E.  Investigation of the feasibility of using wind power for space heating in colder climates  [DOB/DP-03533/T3]  CROWAUBR, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation  [FE-2305-33]  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2  [FE-2305-30]  CROWLER, J. H.  Satellite Power Systems (SPS) cost review  [DOE/TIC-11190]  CRUM, B. M.  Electric propulsion for SPS  CRIMES, B. L.  Catalysts for upgrading coal-derived liquids  [DOE/ET-14876/2]  CSOMOB, A.  The new age of high performance kinetic energy storage systems  P0768 A80-48374  CUEVAS, A.  High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination  P0606 A80-46768
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPBB, J. F.  The aluminum-air battery for electric vehicle propulsion  Aluminum air battery for electric vehicle propulsion [UCRL-84443] p0779 N80-32941  COPELABD, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3] p0630 N80-28569  COPPOLA, B. B.  Hilitary jet fuel from shale oil  CORBETT, R. B.  High voltage power systems for military needs p0725 A80-48254  CORLETT, B. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROHAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain  p0625 A80-51684  COSTA, G.  Hydrogen storage in a beryllium substituted TiFe compound  p0661 A80-45060  COSTRLLO, F. A.  Total and non-isotropic diffuse insolation on tilted surfaces	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOE/PP-03533/T3] p0753 N80-32950  CROWAURE, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 N80-32568  CROWLEY, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p0654 N80-32928  CRUM, B. M.  Electric propulsion for SPS  CRIMES, B. L.  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2] p0691 N80-28556  CSOMOR, A.  The new age of high performance kinetic energy storage systems p0768 A80-48374  CUEVAS, A.  High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination p0606 A80-46768  CULIK, J.  Pilot line report: Development of a high efficiency thin silicon solar cell
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. P.  The aluminum-air battery for electric vehicle propulsion  P0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCEL-84443]  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, R. B.  Hilitary jet fuel from shale oil  CORDETT, R. E.  High voltage power systems for military needs p0725 A80-48254  CORLETT, R. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROFAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain  P0625 A80-51684  COSTA, G.  Hydrogen storage in a beryllium substituted TiPe compound  P0661 A80-45060  COSTRLLO, F. A.  Total and non-isotropic diffuse insolation on tilted surfaces	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80-32950  CROWAURR, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation  [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2  [FE-2305-30] p0710 N80-32568  CROWLER, J. H.  Satellite Power Systems (SPS) cost review  [DOE/TIC-11190] p0654 N80-32928  CRUB, B. M.  Electric propulsion for SPS  CRUBS, B. L.  Catalysts for upgrading coal-derived liquids  [DOE/ET-14876/2] p0691 N80-28556  CSOMOB, A.  The new age of high performance kinetic energy storage systems  p0768 A80-48374  CUEVAS, A.  High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination  p0606 A80-46768  CULIK, J.  Pilot line report: Development of a high
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  P0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443] p0779 N80-32541  COPELABD, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3] p0630 N80-28569  COPPOLA, B. B.  Hilitary jet fuel from shale oil  CORBETT, R. B.  High voltage power systems for military needs p0725 A80-48254  CORLETT, B. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROHAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain  p0625 A80-48341  COSTA, G.  Hydrogen storage in a beryllium substituted TiFe compound  p0661 A80-45060  COSTELLO, F. A.  Total and non-isotropic diffuse insolation on tilted surfaces  p0599 A80-46571  COURREGES, F. G.  Oxide/semiconductor photovoltaic heterojunctions based on CdTe or InF	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOE/PP-03533/T3] p0753 N80-32950  CROWAURE, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 N80-32568  CROWLEY, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p0654 N80-32928  CRUME, B. M.  Electric propulsion for SPS  CATALYSTS for upgrading coal-derived liquids [DOE/ET-14876/2] p0691 N80-28556  CROMOR, A.  The new age of high performance kinetic energy storage systems p0768 A80-48374  CUEVAS, A.  High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination  CULIK, J.  Pilot line report: Development of a high efficiency thin silicon solar cell [NSA-CR-163522] p0644 N80-31876  CUMALI, Z. O.  The OASIS computer program for optimization and
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. P.  The aluminum-air battery for electric vehicle propulsion  P0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCEL-84443]  COPELAND, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, R. B.  Hilitary jet fuel from shale oil  CORDETT, R. E.  High voltage power systems for military needs p0725 A80-48254  CORLETT, R. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROMAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain  P0625 A80-51684  COSTA, G.  Hydrogen storage in a beryllium substituted TiFe compound  P0661 A80-45060  COSTELLO, F. A.  Total and non-isotropic diffuse insolation on tilted surfaces  P0599 A80-46571  COURREGES, F. G.  Oxide/semiconductor photovoltaic heterojunctions	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80-32950  CROWAURR, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [PE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PE-2305-30] p0710 N80-32568  CROWLER, J. B.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p0654 N80-32928  CRUB, B. M.  Electric propulsion for SPS  CRUBS, B. L.  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2] p0691 N80-28556  CSOMOB, A.  The new age of high performance kinetic energy storage systems p0768 A80-48374  CUEVAS, A.  High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination p0606 A80-46768  CULIK, J.  Pilot line report: Development of a high efficiency thin silicon solar cell [NASA-CR-163522] p0644 N80-31876  CUEMALI, Z. O.
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. F.  The aluminum-air battery for electric vehicle propulsion  P0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  P0779 N80-32541  COPELABD, R. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3]  COPPOLA, B. B.  Hilitary jet fuel from shale oil  CORBETT, R. B.  High voltage power systems for military needs p0725 A80-48254  CORLETT, B. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROHAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain  P0625 A80-48341  COSTA, G.  Hydrogen storage in a beryllium substituted TiFe compound  COSTELLO, F. A.  Total and non-isotropic diffuse insolation on tilted surfaces  p0599 A80-46571  COURREGES, F. G.  Oxide/semiconductor photovoltaic heterojunctions based on CdTe or Inp  P0603 A80-46732  COUTURES, J. P.  Solar gasification of charcoal, wood and paper	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80-32950  CROWAURE, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [FE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2  [FE-2305-30] p0710 N80-32568  CROWLEY, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p0654 N80-32928  CRUME, B. M.  Electric propulsion for SPS  CATALYSTS for upgrading coal-derived liquids [DOE/ET-14876/2] p0691 N80-28556  CRIMES, B. L.  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2] p0691 N80-28556  CSOMOB, A.  The new age of high performance kinetic energy storage systems p0768 A80-48374  CUEVAS, A.  High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination  CULIK, J.  Pilot line report: Development of a high efficiency thin silicon solar cell [NASA-CR-163522] p0644 N80-31876  CUHALI, Z. O.  The OASIS computer program for optimization and simulation of integrated systems
High-efficiency AlGaAs/GaAs concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952  COOPER, J. P.  The aluminum-air battery for electric vehicle profulsion  P0768 A80-48373  Aluminum air battery for electric vehicle propulsion [UCRL-84443]  COPELAND, B. J.  Conversion system overview assessment. Volume 3: Solar thermal/coal or biomass derived fuels [SERI/TR-35-078-VOL-3] p0630 N80-28569  COPPOLA, B. N.  Hilitary jet fuel from shale oil  CORDETT, R. E.  High voltage power systems for military needs p0725 A80-48254  CORLETT, R. C.  Theory of reverse combustion along fissures in fuel which gasifies at depth  COROMAS, A.  Solar radiation incident on tilted flat surfaces in Barcelona, Spain  P0625 A80-48341  COSTA, G.  Hydrogen storage in a beryllium substituted TiPe compound  COSTELLO, P. A.  Total and non-isotropic diffuse insolation on tilted surfaces  P0599 A80-46571  COURREGES, P. G.  Oxide/semiconductor photovoltaic heterojunctions based on CdTe or InP  P0603 A80-46732	Scaling and the start-up phase of space industrialization  p0598 A80-46386  CROMACK, D. B.  Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80-32950  CROWAURE, D. C.  Investigation of mechanisms of hydrogen transfer in coal hydrogenation [PE-2305-33] p0697 N80-29517  Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PE-2305-30] p0710 N80-32568  CROWLER, J. H.  Satellite Power Systems (SPS) cost review [DOE/TIC-11190] p0654 N80-32928  CRUBE, B. H.  Electric propulsion for SPS  CRUBES, B. L.  Catalysts for upgrading coal-derived liquids [DOE/ET-14876/2] p0691 N80-28556  CSOMOR, A.  The new age of high performance kinetic energy storage systems  p0768 A80-48374  CUEVAS, A.  High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination  CULIK, J.  Pilot line report: Development of a high efficiency thin silicon solar cell [MASA-CR-163522] p0644 N80-31876  CUHALI, Z. O.  The OASIS computer program for optimization and simulation of integrated systems

CUPPS, C. Q.	DAPPERT, D.
Recent activity in U.S. tar sand	Nickel-zinc batteries for RPV applications [AD-A088594] p0780 N80-33908
CURRAN, M. J.	DARLINGTON, I.
Alternate synthesis of electrolyte matrix for molten carbonate fuel cells	Effects of gasohol on idle HC and CO emissions [PB80-190655] p0590 N80-33018
p0721 A80-47135 Alternate fabrication process for molten carbonate	DARTHELL, P. L. Energy: Careful conservation or regulated waste
fuel cell electrolyte structures p0721 A80-47136	p0592 N80-33951
CORRIE, J. B.	D.C. electrical conductivity of Green River oil
Assessment of solar thermal concepts for small power systems applications	shales p0685 A80-50278
P0618 A80-48463	DAS, H. B. Controlled cadmium telluride thin films for solar
Human comfort and auxiliary control considerations in passive solar structures	cell applications (emerging materials systems for solar cell applications)
[LBI-10034] p0640 N80-29903	[DOE/ET-23023/T3] p0642 N80-30921 DAS, R. L.
Selectivity improvement in the solvent refined coal process. I - Detailed first-stage reaction studies - Coal mineral catalysis. II - Detailed second-stage reaction studies - Hydrotreating of	Power processing and control requirements of dispersed solar thermal electric generation systems p0619 A80-48465
coal liquids	DAUBE, K.
p0679 A80-49630	Fuel cell applied research: Electrocatalysis and materials
An update of OTEC baseline design costs p0718 A80-44604	[BNL-51053] p0742 N80-28920
CUTTING, J. C.	Some characteristics of low-cost silicon sheet
Closed cycle MBD power plant and retrofit	p0605 A80-46756
optimization application p0717 180-44231	Energy from wood waste - A case study
Near term commercialization of MHD power generation using coal/oil fuel	p0670 A80-47594
P0724 A80-48225	The fate and effects of crude oil spilled on subarctic permafrost terrain in interior Alaska
Production of light aromatics from coal hydrogenates p0660 A80-49631	[PB80-187305] p0585 N80-31984 DAVIDSON, B. J.
מ	Large-scale electrical energy storage p0761 A80-44241
DABKOWSKI, H. J.	DAVIDSON, J. H. Simulation and evaluation of latent heat thermal
Upgrading of coal liquids for use as power generation fuels	energy storage heat pump systems p0771 A80-48478
[EPEL-AF-1225] p0699 N80-30547 DAHIYA, R. P.	DAVIES, L. W. Surface passivation of inversion layer m.i.s.
Cathode sheaths in potassium seeded MHD combustion plasmas	solar cells p0612 A80-48150
p0720 A80-46158	DAVIS, D.  The new age of high performance kinetic energy
Research on Cu sub x S/(cd, Zn)S photovoltaic	storage systems p0768 A80-48374
[LBL-10791] p0654 N80-32927	DAVIS, G. W.
DALESSANDRO, J. Conceptual design of RST: An rf-driven,	Study of methane fuel for subsonic transport aircraft
steady-state Tokamak	[NASA-CR-159320] p0708 N80-32533
[EPRI-AP-1351] p0751 N80-32233	DAVIS, J. R.
DALTON, T. C. Haterial evaluation and testing program for OTEC	Degradation of solar cell performance by areal inhomogeneity
riser cable p0728 A80-48351	p0624 A80-51112 DAVIS, P. K.
DANCEUL, A. P. Selection of the optimal design parameters of an	The OASIS computer program for optimization and simulation of integrated systems
aircraft flywheel-type power supply system p0761 A80-47391	p0571 A80~48333
DAMG, V. D. Application of the fusion reactor to	Electric utilities and residential solar systems [BNL-27711] p0638 N80-29888
thermochemical-electrochemical hybrid cycles and electrolysis for hydrogen production from water	DAY, A. C. Solar thermophotovoltaic space power system
p0664 A80-51460 Alternative process schemes for coal conversion	p0614 A80-48208
[BN1-51117] p0692 N80-28560  DANG, VD.	Chemical and physical stability of refractories for use in coal gasification
HYFIRE - Fusion-high temperature electrolysis system p0731 A80-48448	[COO-2904-15] p0690 N80-28478 DE MARCHI DESENZANI, P.
DAWIEL, S. B.  Bechanisms of nitrogen heterocycle influence on	Alternatives for heat supply in biomass energy conversion systems
turbine fuel stability	p0673 A80~48277
p0695 880-29327  DABIELS, E. J.	DE MBY, G. Optimized grid patterns for Cu2S-CdS solar cells
Study of methane fuel for subsonic transport	p0621 A80-49322
aircraft [NASA-CR-159320] p0708 N80-32533	DR PAZ, J. P. Development of a falling-bed fusion blanket system
DAO, E.  Development of solar driven absorption air	for synthetic fuel production p0678 A80-48447
conditioners and heat pumps [LBL-10771] p0642 N80-30925	DE PENA, R. G. Sulfate aerosol production and growth in
	coal-operated power plant plumes

p0572 A80-48533

DE VOS, A. Influence of meteorological conditions on the	DEVINE, W., D., JE. Assessment of industrial energy conservation by
design of solar energy dc-ac inverters p0609 A80-46795	unit processes [ORAU/IEA-80-4(M)] p0584 M80-3193
DE VRIES, E. P. W. Simulation of a solar energy system by means of an	DEWIE, E. L. Energy principle with global invariants for
electrical resistance network p0625 A80-51686	toroidal plasmas p0717 180-4397.
DEFREECE, D. A. Energy conversion considerations of the STARFIRE	DRY, A. B. Safety studies on Li/SO2 cells. IV -
connectial fusion power plant p0733 A80-48490	Investigations of alternate organic electrolytes for improved safety
DEGLER, G. H.	p0737 A80-5050
Co-firing densified refuse derived fuel in a spreader stoker fired boiler	Safety studies on Li/SO2 cells. V - Effect of design variables on the abuse resistance of
p0684 A80-50018 DEGREY, S. P.	hermetic D cells p0737 A80-5050
Hybrid vehicle potential assessment. Volume 3: Parallel systems	DHOORE, F. Experimental optimization of the efficiency of
[CONS-4209-T1-VOL-3] p0776 N80-31270 DEHLI, H.	n/+/-p-p/+/ and p/+/-n-n/+/ silicon solar cells p0601 180-4670
Increased information acquisition and transmission	DI PIETRO, B.
as a condition for the further development of energy economy structures	The lithium-sulfuryl chloride battery - Discharge behaviour
p0575 A80-50826	. p0772 A80-4877
DELAFOSTAISE, S.  Recycling of effluents and organic residues into	DIAB, M. R. A two-dimensional analysis of flat plate
methane by anaerobic digestion - New perspectives p0683 A80-49995	air-heating solar collectors [ASME PAPER 80-HT-117] p0612 A80-4803
DELEGN, P.	DICK, B. H.
Potential displacement of petroleum imports by solar energy technologies	Low maintenance lead-acid batteries for energy storage
[SERI/TR-352-504] p0656 H80-32959	p0765 A80-4832
DELL, R. H.	DICK, R. S.
Batteries for solar electricity p0605 A80-46747	Collector temperature effects on the performance of advanced thermionic converters and nuclear
Parametric study of prospective early commercial	electric propulsion systems p0730 A80-4842
OCHBD power plants /PSPEC/ p0717 A80-44106	DICK, R. S., JR.  Design study of a coal-fired thermionic
DELORME, C. Daily irradiations measured on three photovoltaic	/THI/-topped power plant p0730 A80-4842
systems in Toulouse p0620 A80-48791	DIEL, E.  The investment demand of energy economy and its
DEMCZYK, B. G.	financing
Performance and structural characteristics of the	p0575 A80~5082
iron-air battery system p0767 A80-48371	DETRICE, G. Development of high temperature resistant, solar
DEMICHELIS, F. A solar thermophotovoltaic converter	absorber surfaces [BHFT-FB-T-79-70] p0640 H80-2990
p0597 A80-46256	DIETRICH, M. W.
DENOIT, D. S. Resistance rise in sodium-sulphur cells p0774 A80-51698	Energy conservation and environmental benefits of thermal energy storage systems in the pulp and
DEMUTE, O. J.	paper industry p0763 A80-48194
Analysis of binary thermodynamic cycles for, a	DIGUET, D.
moderately low-temperature geothermal resource p0725 A80-48267	Improvement of phosphorus diffused silicon solar cells by laser treatment
DRHT, J. B. The potential of energy farming for transport	p0606 A80-4676
fuels in New Zealand	Heat transfer in slurry preheaters for coal
[PB80-154248] p0693 880-28572 The potential of energy farming for transport	liquefaction plants p0678 A80-4843
fuels in New Zealand, aprendices	DILLARD, J. G.
[PB80-154255] p0693 N80-28573 DERINGER, J. J.	Development and application of analytical techniques to chemistry of donor solvent
Energy conservation measures for commercial buildings used in life cycle cost analysis	liquefaction [FE-2696-T4] p0695 N80-29472
p0571 180-48514	DILHORB, J. A.
DEROSSET, A. J. Upgrading of coal liquids: Hydrocracking of EDS	MHD electrode development [FE-15529-5] p0748 H80-3122
process derived gas oils	DIMARGGORAS, A. D.
[FE-2566-33] p0699 880-30545 DEROUIH, C.	Synthesis of four bar linkages for solar tracking p0624_A80-5167
Fuel cell systems for vehicular applications [SAE PAPER 800059] p0736 A80-49720	System design, tests results, and economic
DESALVO, A.  Effect of laser irradiation on the characteristics	analysis of a flywheel energy storage and conversion system for photovoltaic applications
of implanted layers for silicon solar cells	[COO-4094-70] p0746 N80-3092
p0602 A80-46711 DESOHBER, A.	DISALVO, P. J.  Photoelectrochemical compatibility of n-WSe2 and
Study of sandwich type glass encapsulation p0602 A80-46714	n-BoSe2 with various redox systems p0610 A80-4714
DESCUEA, G.	DITTERBORFER, A. C.
Mid-range energy forecasting system - Structure, forecasts, and critique	Sulfate aerosol production and growth in coal-operated power plant plumes

	:
DIVER, R. B. Hydrogen and oxygen from water. III - Evaluation	DRAKE, J. P. Linear analysis of the double-tearing mode
of a hybrid process p0661 180-45298	DRAKR, B. L. p0718 A80-44390
DIVECT, I. I. Hagnetoplasma compressor with an explosion-driven	Siting handbook for small wind energy conversion systems
magnetic power generator p0717 A80-44185	[PNL-2521-REV-1] p0747 N80-30941 DRESNER, J.
DIXIT, B. S.  Economics of wood energy systems for industries p0673 A80-48275	Amorphous thin films for solar-cell applications [DOE/ET-21074/4] p0653 N80-32921 DREVER, J. L.
DJAPAE, E. Liquid fuels from biomass: Catalysts and reaction	The push-pull test - A method of evaluating formation adsorption parameters for predicting
conditions [LBL-9789] p0705 H80-31646	the environmental effects on in-situ coal gasification and uranium recovery
DO, L. B. Circulating fluidized bed boiler	DREW, H. S. p0576 A80-52968
PO672 A80-48201	Sizing procedure and economic optimization methodology for seasonal storage solar systems
Characterization of a potential underground coal gasification site in the State of Washington	DRIBS, W. C.
p0676 180-48345	A method to reclaim metallic material and energy
DOGE, D. M. Small Wind Turbine Systems 1979: A Workshop on R	from automobiles p0684 A80-50024
and D Requirements and Utility	
Interface/Institutional Issues. Volume 1: R and D requirements	DRIGGRES, J. H. Silicon web process development [NASA-CR-163386] p0631 N80-28864
[RFF-3014-VOL-1] p0747 880-30943 POLLARS, B.	DRORGE, J. W. Thermophysical properties of coal liquids
Solar-powered Rankine engine assists air	[BHI-2043] p0701 W80-30557
conditioning systems with electrical generating capability	DROST, M. E. Assessment of solar thermal concepts for small
p0611 A80-47596	power systems applications
DONLINGER, J.  Photovoltaic module electrical termination design	p0618 A80-48463
requirement study	Systems assessment of heavy ion beam fusion drivers [DOE/DP-40039] p0754 M80-33247
DOHNEL, C. P.	DUBAH, P.
Nickel hydrogen battery for load leveling application	Closed-cycle helium gas turbine for solar tower power plant
p0766 A80-48328 DONNELLY, J. J., JR.	[OHERA, TP NO. 1980-28] p0597 A80-46228 DUBIS, D.
Study of hydrogen-powered versus battery-powered automobiles	Assessment of Synthane mechanical equipment [MTI-79TR5] p0710 M80-32572
[ATR-79 (7759) ~ 1-VOL~1] p0665 880-31271 DONNELLY, P. P.	DUBON, J.  D.C. electrical conductivity of Green River oil
Municipal solid waste and district heating - A case study	shales p0685 A80-50278
p0727 180-48285	DUBROVSKII, L. A.
Condensation processes in coal combustion products	Investigation of the service life of aluminum
[DOB/BR-10456/1] p0708 N80-32473	mirrors on metal substrates at high temperatures p0611 A80-47158
DORR, H. C.	DUCHI, H.
Development and application of analytical techniques to chemistry of donor solvent	Photovoltaic institutional issues study [SAND-79-7054] p0584 N80-31950
liquefaction [PB-2696-T4] p0695 N80-29472	Concentrating solar collector test results
Development and application of analytical techniques to chemistry of donor solvent	[SAND-80-0801C] p0633 N80-28912
liquefaction	Advances in theory, fabrication and applications
[DOB/PC-20041/T1] p0712 880-33520 DOROFERV, V. G.	of bifacial solar cells p0606 A80-46769
Selection of the optimal design parameters of an	DUFFY, D.
aircraft flywheel-type power supply system p0761 A80-47391	Design, construction, and operation of a 150 kW solar-powered irrigation facility, phase 2
DORSON. W.	[ALO-4159-1] p0645 N80-31903
Trends in financing LNG projects p0573 A80-49398	DUPPY, T. B. Automotive storage of hydrogen using modified
DOSAJ, V. D.	magnesium hydrides
Progress on the Dow Corning process for solar-grade silicon	[SAN-1167-1] p0666 N80-31650 DUGGER, G. L.
p0600 A80-46699 bosaejos, C. B.	Projected costs for electricity and products from OTEC facilities and plantships
Remote sensing applied to the prospecting of	p0728 A80-48349
geothermal anomaly in Caldas Novas County, State	Report of the 6th Ocean Thermal Energy Conversion Conference. Ocean Thermal Energy for the 1980's
of Goias, Brazil [INPE-1792-RPE/164] p0712 N80-32837	[CONF-790631-1] p0701 N80-30922
DOSTER, J. H. Simulation and evaluation of latent heat thermal	DULIKRAVICH, D. S.
STREETSTON GRE EIGTESS AT TREETS NEWS FREETS	
energy storage heat pump systems	WIND: Computer program for calculation of three dimensional potential compressible flow about
energy storage heat pump systems p0771 A80-48478	WIND: Computer program for calculation of three dimensional potential compressible flow about wind turbine rotor blades
energy storage heat pump systems pQ771 A80-48478  DOYLE, H. E. Field experiences with rotordynamic instability in	WIND: Computer program for calculation of three dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357
energy storage heat pump systems p0771 A80-48478 DOYLE, H. E.	WIND: Computer program for calculation of three dimensional potential compressible flow about wind tuchine rotor blades [NASA-TP-1729] p0755 N80-33357
energy storage heat pump systems p0771 A80-48478  DOYLE, H. E. Field experiences with rotordynamic instability in high-performance turbomachinery	WIND: Computer program for calculation of three dimensional potential compressible flow about wind turbine rotor blades [NASA-TP-1729] p0755 N80-33357 DDUCAM, C. S. Silicon web process development

	·
DUBCAB, L. M. Solar power satellites - The ionospheric connection	EDLIBGION, 1.
p0757 A80-46397	Particle confinement scaling experiments in the Culbam Levitron
Effects of microwave beams on the ionosphere p0757 180-46881	p0719 A80-4465
DUNLOP, J. D. Status of COMSAT/INTELSAT nickel-hydrogen battery	Simulation and evaluation of latent heat thermal energy storage heat pump systems
technology p0770 180-48437	p0771 A80-48474
DUPAS, A.	Assessment of current research and development in
The potential global market in 2025 for Satellite Solar Power Stations	support of the U.S. coal liquefaction demonstration plants program
p0598 180-46382	p0677 180-48420
Generalization of the two-dimensional optical	Energy models as a tool for planning
_ analysis of cylindrical concentrators p0599 180-46566	p0577 A80-54039
DURLAK, E. R. Solar heating of buildings and domestic hot water	<pre>Feasibility study on a solar house heating system with a low quality thermal flow</pre>
[AD-A085815] p0634 #80-29532 DVERWIAKOV, V. S.	[EUR-6696-EN] p0655 N80-32939
A study of the heat-induced fracture	Safety of wind energy conversion systems (WECS):
characteristics of materials under intense radiant heating	Preliminary study [PFA-HU-2126] p0742 H80-28933
p0609 180-46815	EBEICEE, E. L.  The extraterrestrial imperative. III - New
Characterization of open-cycle, coal-fired MHD generators	earth-space energy metabolism. I p0688 A80-5332
[ARI-BP-46] p0751 880-32234	BIESTRIE, E.
E	Development of a bipolar Zn/Br2 battery p0767 A80-4836
EARL, W. B.	EKSTROM, P. A. Forkshop on Satellite Power Systems (SPS) Effects
The potential of energy farming for transport fuels in New Zealand	on Optical and Eadio Astronomy [COMP-7905143] p0643 M80-3143
[PB80-154248] p0693 #80-28572	ELIEEBB, K. F. A study of industrial hydrogen and syngas supply
The potential of energy farming for transport fuels in New Zealand, appendices	systems
[PB80-154255] p0693 N80-28573 BATON, R.	[NASA-CE-163523] p0666 N80-31624 BLIMALDE, B.
Material evaluation and testing program for OTEC riser cable	Optical and calorimetric measurements of curreous sulphides thin films
p0728 A80-48351	p0607 A80-4677
Large advanced waste treatment plants	Sorption of moisture and methane on Fruitland coal
p0569 A80-44412	p0676 A80-48340
Energy conservation and environmental benefits of thermal energy storage systems in the pulp and	Potential for improved silicon ribbon growth through thermal environment control
paper industry p0763 &80-48194	p0601 A80-46704 BLSAYED, N. N.
EDELPHIT, L. H. Regenerative flywheel energy storage system	Theoretical study of absorbed solar energy in
[UCRL-13982-REV-1] p0775 N80-28884	<pre>multi-layer absorber coatings for receivers of solar concentrators. II - Beat transfer analysis</pre>
EDES, A. Analysis of solar collector array systems using	[ASME PAPER 80-HT-105] p0612 A80-48034
thermography [SBRI/TR-351-494] p0632 880-28894	Electrowinning of silicon from K2SiP6-molten fluoride systems
Thermographic techniques applied to solar	p0622 180-50510
collector systems analysis [SEBI/TP-351-540] p0655 H80-32946	
Analytical evaluation of a solar	p0572 180-49391
thermophotovoltaic converter [SAND-78-1962] p0649 H80-31954	New directions in energy recovery from petroleum refinery oily sludges
EDESESS, M. Solar ponds for district heating and electricity	p0685 A80-50034
generation	Brini - A completion to solid fuels
p0618 A80-48367 Investigation of learning and experience curves	p0684 A80-50017
[SEBI/TR-353-459] p0646 M80-31911 Solar ponds and their applications	Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate
[SERI/TP-733-617] . p0655 N80-32947 BDESKUTY, P. J.	p0774 A80-51690
The dc superconducting power transmission line	Erron Donor Solvent Coal Liquefaction Process -
project at LASL: US DOE division of electric energy systems	Development Program Status p0677 A80-48430
[LA-8323-FE] p0759 880-30656 RDGAR, T. P.	BRASHUS, P. C. Strategies for rational utilization of bituminous
Basic Research in Engineering: Process and Systems Dynamics and Control. High Priority	coal deposits in the German Federal Republic p0685 180-50814
Research Needs Relevant to Energy	ERGUE, S.
[FE-2468-65] p0590 H80-33167 RDGERTON, B. H.	Biomass liquefaction efforts in the United States [LBL-10456] p0696 B80-29512
Second law and radiation p0738 A80-51203	Liquid fuels from biomass: Catalysts and reaction conditions
	[LBL-9789] p0705 N80-31646

•	
RREST, M.	•
Miniplant and bench studies of	
fluidized-bed coal combustion	
[PB80-188121]	P0712 N80-32999
RSCHER, W. J. D.	ent. Volume 1:
Solar/hydrogen systems assessme Solar/hydrogen systems for th	e 1985 - 2000 time
frame.	16 1303 Z000 CIME
[ NASA-CR-163392 ]	p0665 N80-28865
Study of hydrogen-powered versu	
automobiles	
[ATR-79 (7759) -1-VOL-1]	p0665 N80-31271
Assessment of hydrogen compress	or technology for
energy storage and transmissi [ORO-5598-T1]	p0667 N80-32922
ESBMAN, P. P.	P0001 B00-32322
New approach to electrode curre	nt collection for
Lial/ircn sulfide cells	
•	p0763 A80-48191
ESTEVA, D. J.	
Solar energy conversion through	biophotolysis
[SAH-0034-239-1-T2]	p0666 N80-31927
ESTEVE, D. Accurate computer analysis of s	colar cells
including band-gap variation	
the Al/x/Ga/1-x/AsGaAs struct	
	p0607 A80-46782
ESTRADA, H.	•
Life cycle cost analysis in res	sidential buildings
and consumer appliances	-0570 300 40545
PROMITO D D	p0572 A80-48515
<b>BUSTIS, R. H.</b> Study of the insulating wall be	nundary layer in a
Faraday MHD generator	andary rajor in a
-	p0722 A80-47763
EUVRARD, A.	-
Engineering studies on the opti	mization of the
collection subsystem of A I	W photovoltaic
facility	-0.00 200 0.00
DELMO D D	P0609 A80-46794
EVANS, D. B. Spectral character of solar and	i circumsolar
radiation	
[LBL-10802]	p0653 N80-32916
BVIBS, J. C., JE.  The planar sultijunction cell -	
The planar multijunction cell -	· A new solar cell
for earth and space	-0642 300 #0705
PERCETNOS Y N	p0613 A80-48205
EVDORIMOV, V. H.  Theoretical investigations into	collection
coefficient for Cu/2-x/S-CdS	cells with
coefficient for Cu/2-x/S-CdS allowance for surface states	at interface
	. p0610 A80-47151
BVBN. J.	
Boonomic and technical evaluati	on of the Ames,
Iowa solid waste recovery sys	p0683 A80-50005
EVENSIZER, J.	PAGG2 WOA-30002
A methodology for the environme	ental assessment of
advanced coal extraction syst	
[ NASA-CR- 163570 ]	p0586 N80-32827
ENAN, J.	Land to the American
Development of space-qualified	
	p0658 N80-33888
BWB, H. H. The influence of contact pressu	ire on the
performance of supported gas	diffusion
electrodes in alkaline H2-02-	fuel cells
	p0739 A80-51459
Buringmann, D.	-
The significance of the gas eco	
viewpoint of environmental pr	cotection
	p0575 A80-50821

F

FABRE, E.

Barly assessment of the photovoltaic potentialities of RAD polysilicon sheets p0600 A80-46701

FACTOR, H. H.

A packed bed dehumidifier/regenerator for solar

air conditioning with liquid desiceants
p0595 A80-45312

PADDICK, R. R.

Experimental design for Hydraulic Transport

Research Pacility

[FE-3274-1]

p0759 H80-29629

PELDER. B. M. PAHIDY, T. S. A theoretical study of the modelling and control of a solar water electrolysis plant Analysis of the application of thermogalvanic cells to the conversion of low grade heat to electricity E0729 A80-48390 PARREBBBUCH, A. L.
Oxide/semiconductor photovoltaic heterojunctions based on CdTe or InP p0603 A80-46732 FARHR, A.
Chemical and physical stability of refractories for use in coal gasification [COO-2904-15] p0690 N80-28478 FALCO. C. H. Structure of amorphous silicon and silicon hydrides p0599 A80-46647 Partial liquefaction of coal by direct hydrogenation [PB-2044-51] p0699 N80-30540 PALLOS, P. T. Reaction modelling and correlation for flash hydropyrolysis of lighite p0678 A80-48433 The flash hydropyrolysis of lignite and sub-bituminous coals to both liquid and gaseous hydrocarbon products p0679 A80-49626 PAN, J. C. C. High-efficiency InP homojunction solar cells .p0598 A80-46496 Efficient Gals shallow-homojunction solar cells on single-crystal GaAs and Ge substrates p0608 A80-46783 Concentration and temperature performances of Gals-Gallas solar cells p0603 A80-46734 PANINGER, G. Regenerative energy sources for the production of low temperature heat: Energy sources, energy types, and energy conversion; results and applications; measures to promote use [ISBN-3-7041-0038-2] p0 p0702 N80-30951 PANSTER, N.
Financing of renewable energy sources /solar, wind and biomass energy sources/ p0572 A80-49392 FARRIS, P. F.
Development of molten carbonate fuel cell power plant technology [DOE/ET-15440/1] p0750 N80-31938 PARUBLL, D. Plasma-sprayed coatings for very high temperature solar absorbers [CONF-791021-3] p0631 N80-28875 PATTIBER, V.

Effluent-free flue gas scrubbing process to
separate the fine dust and the noxious gases p0574 A80-49968 Performance loss due to transient heat transfer in the cylinders of Stirling engines p0730 A80-48410 PEDUSKA, E. An advanced technology iron-nickel battery for electric vehicle propulsion p0766 A80-48327 Planning for electric utility solar applications:
The effects on reliability and production cost
estimates of the variability in demand
[SERI/TP-351-545] p0587 880-32 p0587 N80-32888 PRIGRISON, R. S. Blectrowinning of silicon from K2SiF6-molten

fluoride systems

PELDER, R. H.

FEJER, A. A.
Wind energy for electric vehicle recharge

Coal gasification/gas cleanup test facility: Volume 1. Description and operation [FB80-188378] p0707 B

p0622 A80-50510

p0707 M80-31990

nonlinear-power take-off, with application to wave-power conversion

Improvement of phosphorus diffused silicon solar

Thin, high efficiency silicon solar cells

cells by laser treatment

p0739 A80-51464

p0658 N80-33885

p0606 A80-46763

PINSON, M. L.
Coal processing for fuel cell utilization. Task
11: Pluidized bed coal gasification model; data PRLDMAE, K. T., JE.
Analysis of a passive heat pipe cooled solar photovoltaic receiver rundized bed coal gasification model: dat analysis and predictions [HETC-8450-T1] p0701 F80-30 [Coal processing for fuel cell atilization: Task 9: One-dimensional (stream) posts [Coal processing for fuel cell atilization: [SAND-80-7011] p0651 N80-32885 PBBG, T. p0701 #80-30909 Theory of polycrystalline silicon solar cells -9: One-dimensional (streamtube) model for entrained-flow gasifier, analysis [METC-8450-T2-VOL-1] p0707 N Bffect of reduction in grain boundary recombination states p0707 N80-31912 D0597 A80-46258 PERRELL, J. E.

Coal gasification/gas cleanup test facility:

Volume 1. Description and operation

[PBE0-188378] p0707 BE PIORITO, G.
Concentration and temperature performances of GaAs-GaAlas solar cells P0707 N80-31990 p0603 A80-46734 PIRESTONE, R. P. PERRETTI. M. Hydrogen storage in a beryllium substituted TiPe Design, engineering and evaluation of refractory liners for slagging gasifiers D0661 A80-45060 p0704 N80-31640 [IITBI-M6043-5] PERTL. W. H.

Tar sands and heavy oil reservoir evaluation using geophysical well logs

D0671 A80-481 PIROR, K.
Overview of thick-film technology as applied to solar cells [ SEBI/TP-331-5411 D0671 A80-48167 p0639 N80-29895 PISCHER, R. D. Optical and calorimetric measurements of cupreous Twenty years of experience with well-water-source-heat pumps at Battelle's Columbus Laboratories sulphides thin films D0607 A80-46779 p0733 A80-48481 FISCHER, R. H. :
Advanced process development in coal liquefaction PRUCET. D. L. Research issues for low cost photovoltaic cells p0676 A80-48379 p0605 A80-46748 FISCHER, W. Development of sodium sulfur batteries PRUSTRL, J. E.
Solar and wind energy - Its contribution to meeting future power requirements [BMFT-PB-T-79-60] p0776 N80-29905 D0623 A80-50816 FISE, H. J.
Utility views on solar thermal central receivers
[SAND-80-8203] p0642 N80-3 PIEDLER, H. H.
Feasibility study: Puel cell cogeneration in a
water pollution control facility, volume 1
p0749 N80-31922 p0642 N80-30911 FISHER, P. W.

Modeling and evaluation of designs for solid PIRLDBOUSE, R. B.
Environmental air quality control from the inside hydrogen storage beds [CONF-800616-8] p0666 N80-32554 looking out p0592 N80-33960 Processing of coal, oil sand and heavy oil in situ by electric and magnetic fields FIRLDHOUSE, L.
Navy-New Hampshire wind energy program D0669 A80-44846 FITSPATRICE, G. Q.
Collector temperature effects on the performance P0701 B80-30904 [AD-A086506] PIBLOS, D. B.
Selecting fines recycle methods to optimize fluid of advanced thermionic converters and nuclear hed combustor performance electric propulsion systems p0671 A80-48169 D0730 A80-48421 FLAT, A.
Theoretical performance of multi-layer grid patterns for solar cells
p0605 PIKS, A. SH. Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in p0605 A80-46752 Predicted effect of grid line aspect ratio on the performance of solar cells large tokamaks p0738 A80-51038 FILLO. J. A. Blanket options for high-efficiency fusion power p0729 A80-48360 p0625 180-51687 FLETCHER, R. A.
Hydrogen and oxygen from water. III - Evaluation HYPIRE - Pusion-high temperature electrolysis system p0731 A80-48448 of a hybrid process Pusion reactors for hydrogen production via p0661 A80-45298 PLETCHER, W. H. W.
Particle confinement scaling experiments in the electrolysis [BNL-27782] p0667 N80-32559 p0667 N80-32559
Advanced synfuels production/power systems
utilizing laser particulate control
[BNL-27783] p0710 N80-32570
Pusion: An energy source for synthetic fuels
[BNL-27891] p0667 N80-33205 Culhan Levitron p0719 A80-44657 PLIAGIE, V. A. Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in PINETII, H.
On the effects of boron and phosphorus primary
impurities in p-type silicon material for solar large tokamaks E0738 A80-51038 Global model of countercurrent coal gasifiers D0606 A80-46758 p0686 A80-51571 PINK. D. J. FLORES. C. Carbohydrate crops as a renewable resource for fuels production. Volume 3: Juice preservation [BMI-2031-VOL-3] p0696 #80-295 Concentration and temperature performances of GaAs-GaAlAs solar cells p0696 N80-29511 n0603 A80-46734 PLOWER, J. O. PINKE, R. C. Synchronous energy technology program Describing-function method for estimating the p0657 N80-33466 performance of a dynamic system having

p0730 A80-48424

p0648 N80-31949

FODOR, J.

POGARASSY. B.

PINLAYSON, P. C.

PINKELSTRIB, T.
Analysis of a heat-activated Stirling heat pump

studies of potential concepts [SAND-80-7010]

Residential photovoltaic systems: A review and comparative evaluation of four independent

		,	
POH, S. E.		The potential of energy farming for	rancoort
A hybrid water-splitting cycle using	CORRET	fuels in New Zealand, appendices	cransport
sulfate and mixed copper oxides	COPPCE	[PB80-154255]	p0693 N80-28573
	p0664 A80-48503	PRATTI, B. W.	
PONTABEL, A.	-	MHD electrode development	
Landsat imagery in oil exploration -	Six years of	[FE-15529-5]	p0748 N80-31222
experience ·		PREDLEY, R. R.	
T #	p0685 A80-50880	Development of molten carbonate fuel	cell bcmer
POORES, 1. W.		plant technology	-0750 WOO 24020
The potential of energy farming for the fuels in New Zealand	cransport.	[DOE/ET-15440/1] PREERAS, J. B.	p0750 N80-31938
[PB80-154248]	p0693 N80-28572	Environmental protection of the solar	r nower
The potential of energy farming for		satellite	POTEL
fuels in New Zealand, appendices			p0609 A80-46899
[PB80-154255]	p0693 N80-28573	The photoklystron	•
PORGAC, J. M.	•		p0623 A80-50956
Catalyst development for coal liquefa		A computer model of solar panel-plass	
	p0696 N80-29508		p0650 N80-32853
PORNEY, B. G.		PRENCH, B. P.	
Photovoltaics in the U.S.A A progr	p0629 A80-52866	Heat-rejection design for large conce solar arrays	entrating
PORRO, J. B.	PV029 R80-32000	Sviai ditajs	p0614 A80-48211
Kelp processing and biomethanation to	echnology	FRENCH, R. L.	P0014 200 40211
	p0673 A80-48278	Salton Sea solar pond project	
FORT, T., JR.			p0617 A80-48362
Design of land-based, foam OTEC plant	ts for	PRETA, R. K.	
bottoming cycles	p0742 N80-28913	Orban solar photovoltaics potential:	
[COHF-790631-17]	P0742 N80-28913	and modelling study applied to the	San Pernando
FOSTER, R. W. Solar/hydrogen systems assessment.	Volume 1:	Valley region of Los Angeles [NASA-CR-163436]	p0636 N80-29859
Solar/hydrogen systems for the 198		PRIBDAN, J.	poudu 800-29033
frame	2000 1110	The CS/R advanced SNG hydrogasificat:	ion process
[NASA-CR-163392]	p0665 N80-28865		p0674 A80-48292
Assessment of hydrogen compressor te	chnology for	PRIEDMAN, S. H.	**
energy storage and transmission sys		Urban solar photovoltaics potential:	
[ORO-5598-T1]	p0667 N80-32922	and modelling study applied to the	San Pernando
POUCHE, C.		Valley region of Los Angeles	0626 402 00050
Study on the utilization of solar end operation of Spacelab material science		[NASA-CR-163436]	p0636 N80-29859
[ ESA-CR (P) - 1301]	p0640 N80-30348	PRIESERA, S. B.  Deep space network energy program	
POURCHER, B.	P0040 800 30340	beep space necestr emergy program	p0590 N80-33446
Transfer function of a sensible-heat	storage	PRISARDI, T.	
element in periodic regime	• • •	Liquid-metal MED for solar and coal	- System and
	p0774 A80-52974	component status	
FOI, D. L.			p0724 A80-48226
Photochemical study of NOx removal f		PRISSON, L.	
	p0582 N80-30966	Influence of the double exponential	
FOX, E. A. Solar energy utilization by carbanion	n nhotolysis	efficiency and the yield of screen	brinced solar
Solar energy difficultion by carbanion	p0625 A80-51680	cells	p0606 A80-46764
PRALEY, L. D.	P0023 200 3.000	PROBERT, M.	Proces mod total
Circulating fluidized bed boiler		Behavior of secondary lithium and al	uminum-lithium
	p0672 A80-48201	electrodes in propylene carbonate	
PRABCHETTI, V. A.			p0774 A80-51690
Automated multi-sample gas chromatog	raphic	PROST, W.	
analysis of fossil fuel gases	-0702 700 71506	Summary of guidelines for siting win	
[ HIM-2721 ]	p0702 N80-31506	generators relative to small-scale	•
PRANCIS, B. J.  Projected costs for electricity and	products from	two-dimensional terrain features [BLO-2443-77/1]	p0647 N80-31930
OTEC facilities and plantships	products from	FUJITA, T.	P0041 P00-21220
1210 -102111200 F1-1200	p0728 A80-48349	Comparison of advanced engines for pa	arabolic dish
FRANCEBE, J. C.	•	solar thermal power plants	
Simulation of a solar energy system			p0618 A80-48418
electrical resistance network		Thermal buffering of receivers for p	arabolic dish
TD1 T000 1 7	p0625 A80-51686	solar thermal power plants	-0040 100 00440
PRANGOS, A. Z.	ecoisar payor	PUJIWAKA, S.	p0618 A80-48419
Air/rock storage for solar central re stations	sceraer boast	The sun-mill - A version of dunking-	hird ac an
SERCIOUS	p0613 A80-48196	energy convertor of sun's radiation	
PRANK, A. A.			p0596 A80-45459
Plywheel energy management systems for	or improving	PUKUTAHA, A.	•
the fuel economy of motor vehicles		Nonlinear coupling of the slow wave	
[PB80-175300]	p0777 N80-31278	the lower-hybrid waves near the plant	
PRANK, H.			p0720 A80-45291
Electrochemical energy storage system	s for solar	PULKS, B. B.	tor colle with
thermal applications	p0636 N80-29858	Operation of multi-bandgap concentrate a spectrum splitting filter	COT CETTE ALLU
[NASA-CH-163432] FRANK, H. E.	Pe 230 B 00 . 73 630	a phonerum phytitizing titter	p0604 A80-46740
Chem Systems liquid phase methanol	process	POBK, J. B.	E-401 200 40140
	P0677 A80-48383	Process economics and the second law	in
PRABELIE, A. D.	· .	thermochemical hydrogen production	
Materials for fuel cells		of heat transfer	
[PB80-182355]	p0748 N80-30955	7777 0	p0663 A80-48459
The notestial of operar farming for	transport	FUEK, O. Status of coal hydrogenation outside	- Filtone
The potential of energy farming for the fuels in New Zealand	cranatore	Status of coal hydrogenation outside	p0669 A80-45513
[ PB80-154248]	p0693 N80-28572	•	
	-		

p0611 A80-47164

PURLONG, L. R. Research needs for coal gasification and coal	GAMPHI, R.  Beat transfer in slurry preheaters for coal
liquefaction	liquefaction plants
PURNESS, R. p0688 A80-5	GAEGULI, P.
Electric utility solar energy activities: 1979survey	H-Coal processing of Kentucky No. 11 coal and 1980 status of H-Coal
[EPRI-RR-1299-SR] p0631 880-2	8879 p0677 A80-48429 GAEGWAL, S. E.
Photoelectrochemical solar cells based on d-band	Pollutants from synthetic fuels production: Coal
electrochemistry at transition metal diselenid [IS-4724] p0648 N80-3	1952 [PB80-182769] p0707 H80-31986
PURUTABL, Y.  Nonlinear coupling of the slow wave structure wi	GANIC, B. W.  th On the selection of working fluids for OTEC power
the lower-hybrid waves near the plasma surface p0720 A80-4	
PUSEGHI, L. J. Thermionic topping of combined cycle powerplants	GABNOB, B.
and cogeneration applications	transportation applications
p0730 A80-4	
The hydropyrolysis of coal to BTX	GANNON, R. E. Indirect liquefaction via the Avco coal
p0688 A80-5	p0674 A80-48296
G	GAPONOV, A. V.
GAASCH, R. A. Study of a hydro-photovoltaic plant for peak pow	Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in
generation in central and northern European	p0738 A80-51038
countries p0605 A80-4	
GABRIEL, J. Assessment of risks in the financing of major	fluidized-bed coal combustion [PB80-188121] p0712 B80-32999
energy projects p0573 A80-4	GARCIA CAMARERO, R.  9397 Optical and calorimetric measurements of cupreous
GAPPHEY, J.  Soot reduction in diesel engines by catalytic	sulphides thin films
effects	GARG, D.
[BNI-27792] p0585 N80-3	coal process. I - Detailed first-stage reaction
Development of polyimide materials for use in solar energy systems	studies - Coal mineral catalysis. II - Detailed second-stage reaction studies - Hydrotreating of
solar energy systems [DOB/CS-35305/T2] p0636 N80-2 GAIGINSCHI, B.	9870 coal liquids p0679 180-49630
Investigation of the feasibility of methanol as automobile fuel	
p0688 A80-5	
Comparison of advanced engines for parabolic dis	h GAROF, J.
solar thermal power plants p0618 A80-4	Coal gasification combined-cycle system analysis [EPRI-AP-1390] p0713 E80-33601
_, _, _, _, _, _, _, _, _, _, _, _, _, _	8418 [EPRI-AP-1390] p0713 880-33601
Thermal buffering of receivers for parabolic dis solar thermal power plants	h GARO220, B n-CdS/p-Si heterojunction solar cells
Thermal buffering of receivers for parabolic dis solar thermal power plants p0618 A80-4	h GAB <b>0120, H-</b> n-CdS/p-Si heterojunction solar cells 8419 p0626 A80-5249E
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major	h GARO120, M. n-CdS/p-Si heterojunction solar cells 8419
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4	h GAR0120, H- n-CdS/p-Si heterojunction solar cells 8419 p0626 A80-52496 GARREAU, H- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate 9397 p0774 A80-51690
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and	h GAR0120, H. n-CdS/p-Si heterojunction solar cells 8419 p0626 A80-52496 GARBAU, H. Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate 9397 p0774 A80-51690 GARRITY, T. P. Baterial evaluation and testing program for OTEC
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4	GARDIZO, M- n-Cds/p-Si heterojunction solar cells  8419  GARBRAU, M- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  9397  GARRITY, T. P- Material evaluation and testing program for OTEC riser cable  90728 A80-48351
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Pundamentals and techniques of nonimaging optics	GARDIZO, M- n-CdS/p-Si heterojunction solar cells p0626 A80-52498  GARBRAU, M- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  9397  GARRITI, T. P- Material evaluation and testing program for OTEC riser cable  6742  GASPER, J.
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration	GARDIZO, H- n-CdS/p-Si heterojunction solar cells 8419  GARREAU, H- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate 9397  GARRITY, T- F- Material evaluation and testing program for OTEC riser cable  GASPER, J. Hethodology for the comparative assessment of the Satellite Power System (SPS) and alternative
Thermal buffering of receivers for parabolic dis solar thermal power plants  GALIBERT, A.  Assessment of risks in the financing of major energy projects  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  GALLAGEER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration  [DOB/EE-04657/2]  GALLAGEER, H. E.	GARO120, M- n-CdS/p-Si heterojunction solar cells  8419  GARBAU, M- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  9397  GARRITY, T. P. Material evaluation and testing program for OTEC riser cable  6742  GASPER, J. Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [MASA-CR-163049]  p0750 M80-31951
Thermal buffering of receivers for parabolic dissolar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration [DOB/ER-04657/2] p0652 N80-3  GALLAGHER, B. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data bas	GAROIZO, M.  n-CdS/p-Si heterojunction solar cells  64819  GARREAU, M.  Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  9397  GARRITY, T. P.  Material evaluation and testing program for OTEC riser cable  GASPER, J.  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049]  GASTON, S. J.  RCA Satcom F1 and F2 Ni-Cd battery orbital
Thermal buffering of receivers for parabolic dissolar thermal power plants  GALIBRET, A.  Assessment of risks in the financing of major energy projects  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration  [DOB/ER-04657/2]  GALLAGHER, M. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data has [NASA-CR-163596]  GALLOHI, R.	GARDIZO, M- n-CdS/p-Si heterojunction solar cells 8419  GARREAU, M- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate 9397  GARRITY, T. P. Material evaluation and testing program for OTEC riser cable  6742  GASPER, J. Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049]  GASTON, S. J. RCA Satcom F1 and F2 Ni-Cd battery orbital performance  p0769 A80-48394
Thermal buffering of receivers for parabolic dissolar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration [DOE/ER-04657/2]  GALLAGHER, M. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data has [NASA-CR-163596]  GALLOHI, R.  Effect of laser irradiation on the characteristi of implanted layers for silicon solar cells	GAROIZO, M- n-CdS/p-Si heterojunction solar cells  gobble poloce A80-52498  GARRBAU, M- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  gobble poloce poloce poloce poloce poloce riser cable  GARRITY, T. P. Material evaluation and testing program for OTEC riser cable  poloce polo
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration [DOB/ER-04657/2] p0652 N80-3  GALLAGHER, H. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data bas [NASA-CR-163596] p0782 N80-3  GALLONI, E.  Effect of laser irradiation on the characteristi	GAROIZO, M- n-CdS/p-Si heterojunction solar cells  gobble poloce A80-52498  GARRBAU, M- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  gobble poloce poloce poloce poloce poloce riser cable  GARRITY, T. P. Material evaluation and testing program for OTEC riser cable  poloce polo
Thermal buffering of receivers for parabolic dissolar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration [DOE/ER-04657/2]  GALLAGHER, M. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data has [NASA-CR-163596]  GALLOHI, R.  Effect of laser irradiation on the characteristi of implanted layers for silicon solar cells p0602 A80-4  GALLOHAY, T. E.  Interfacing the Tandem Hirror Reactor to the	GARO120, M- n-CdS/p-Si heterojunction solar cells R419  GARREAU, M- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  9397  GARRITY, T. P- Material evaluation and testing program for OTEC riser cable  6742  GASPER, J. Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049]  GASTON, S. J.  ECA Satcom P1 and F2 Ni-Cd battery orbital performance  90769 A80-48394  Computer simulation of solar panel voltage regulation  p0612 A80-48177  GATOS, B. C.
Thermal buffering of receivers for parabolic dissolar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration [DOE/ER-04657/2]  GALLAGHER, M. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data has [NASA-CR-163596]  GALLOBI, B.  Effect of laser irradiation on the characteristi of implanted layers for silicon solar cells p0602 A80-4  GALLOBAY, T. B.  Interfacing the Tandem Mirror Reactor to the sulfur-iodine process for hydrogen production p0662 A80-4	GAROIZO, M.  n-CdS/p-Si heterojunction solar cells  GARRIAU, M.  Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  p0774 A80-51690  GARRIII, T. P.  Haterial evaluation and testing program for OTEC riser cable  GASPER, J.  Hethodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951  GASTON, S. J.  RCA Satcom F1 and F2 Ni-Cd battery orbital performance  p0769 A80-48394  GATES, M. T. Computer simulation of solar panel voltage regulation  p0612 A80-48177  GATOS, H. C.  A multiple p-n junction structure obtained from as-grown C2ochralski silicon crystals by heat
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBRET, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration  [DOB/ER-04657/2] p0652 N80-3  GALLAGHER, M. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data has [NASA-CR-163596] p0782 N80-3  GALLONI, B.  Effect of laser irradiation on the characteristi of implanted layers for silicon solar cells p0602 A80-4  GALLONAY, T. E.  Interfacing the Tandem Mirror Reactor to the sulfur-iodine process for hydrogen production p0662 A80-4  GAMBILL, B. B.  Assessment of current research and development i	GAROTZO, M-  n-CdS/p-Si heterojunction solar cells  GARREAU, M- Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  p0774 A80-51690  GARRITY, T. F. Material evaluation and testing program for OTEC riser cable  p0728 A80-48351  GASPER, J. Hethodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [MASA-CR-163049] p0750 M80-31951  GASTON, S. J.  RCA Satcom P1 and F2 Ni-Cd battery orbital performance  p0769 A80-48394  GATES, M. T. Computer simulation of solar panel voltage regulation  p0612 A80-48177  GATOS, H. C. A multiple p-n junction structure obtained from as-grown Czochralski silicon crystals by heat treatment - Application to solar cells p0595 A80-45121
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Pundamentals and techniques of nonimaging optics for solar energy concentration [DOE/ER-04657/2]  GALLAGHER, H. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data bas [NASA-CR-163596]  GALLOWI, B.  Effect of laser irradiation on the characteristi of implanted layers for silicon solar cells p0602 A80-4  GALLOWAY, T. R.  Interfacing the Tandem Mirror Reactor to the sulfur-iodine process for hydrogen production p0662 A80-4  GAMBILL, W. B.  Assessment of current research and development i support of the U.S. coal liquefaction denonstration plants program	GAROIZO, M.  n-CdS/p-Si heterojunction solar cells  garage poof the condary lithium and aluminum-lithium electrodes in propylene carbonate  garage poor poor poor poor poor poor poor poo
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration [DOE/ER-04657/2]  GALLAGHER, M. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data has [NASA-CR-163596]  GALLOBI, B.  Effect of laser irradiation on the characteristi of implanted layers for silicon solar cells p0602 A80-4  GALLOBAY, T. R.  Interfacing the Tandem Mirror Reactor to the sulfur-iodine process for hydrogen production p0662 A80-4  GAMBILL, E. E.  Assessment of current research and development i support of the U.S. coal liquefaction	GARDIZO, M.  n-CdS/p-Si heterojunction solar cells  GARDIZO, M.  Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  p0774 A80-51690  GARRITI, T. P.  Material evaluation and testing program for OTEC riser cable  p0728 A80-48351  GASPER, J.  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951  GASTON, S. J.  RCA Satcom P1 and F2 Ni-Cd battery orbital performance  p0769 A80-48394  GATES, M. T.  Computer simulation of solar panel voltage regulation  p0612 A80-48177  GATOS, H. C.  A multiple p-n junction structure obtained from as-grown Czochralski silicon crystals by heat treatment - Application to solar cells  GAUL, H. W.  Long-term average performance benefits of parabolic trough improvements
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration [DOE/ER-04657/2] p0652 N80-3  GALLAGHER, H. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data bas [NASA-CR-163596] p0782 N80-3  GALLOWI, R.  Effect of laser irradiation on the characteristi of implanted layers for silicon solar cells p0602 A80-4  GALLOWAY, T. R.  Interfacing the Tandem Mirror Reactor to the sulfur-iodine process for hydrogen production p0662 A80-4  GAMBILL, W. B.  Assessment of current research and development i support of the U.S. coal liquefaction demonstration plants program  p0677 A80-4  GANDEL, M. G. Life cycle test of Air Force nickel-hydrogen	GAROIZO, H.  n-CdS/p-Si heterojunction solar cells  GARREAU, H.  Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  9397  GARRITI, T. P.  Material evaluation and testing program for OTEC riser cable  P0728 A80-48351  GASPER, J.  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049]  P0750 N80-31951  GASTOM, S. J.  RCA Satcom F1 and F2 Ni-Cd battery orbital performance  P0769 A80-48394  GATES, M. T. Computer simulation of solar panel voltage regulation  P0612 A80-48177  GATOS, H. C.  A multiple p-n junction structure obtained from as-grown Czochralski silicon crystals by heat treatment - Application to solar cells n  F0595 A80-45121  GAUL, H. H. Long-term average performance benefits of parabolic trough improvements [SEEL/TR-632-439]  GAVELLOVA, I. P.
Thermal buffering of receivers for parabolic dis solar thermal power plants  p0618 A80-4  GALIBERT, A.  Assessment of risks in the financing of major energy projects  p0573 A80-4  GALL, S.  Solar cells with concentrating collectors and integrated heat use system  p0604 A80-4  GALLAGHER, J. J.  Fundamentals and techniques of nonimaging optics for solar energy concentration [DOE/ER-04657/2]  p0652 N80-3  GALLAGHER, M. E.  Forecasts of energy technology. Citations from the International Aerospace Abstracts data has [NASA-CR-163596]  p0782 N80-3  GALLOWAY, T. R.  Interfacing the Tandem Mirror Reactor to the sulfur-iodine process for hydrogen production p0662 A80-4  GAMBILL, E. E.  Assessment of current research and development i support of the U.S. coal liquefaction demonstration plants program	GAROIZO, H.  n-CdS/p-Si heterojunction solar cells  GARREAU, H.  Behavior of secondary lithium and aluminum-lithium electrodes in propylene carbonate  p0774 A80-51690  GARRITI, T. P.  Material evaluation and testing program for OTEC riser cable  p0728 A80-48351  GASPER, J.  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-31951  GASTON, S. J.  RCA Satcom P1 and F2 Ni-Cd battery orbital performance  p0769 A80-48394  GATES, M. T.  Computer simulation of solar panel voltage regulation  p0612 A80-48177  GATOS, H. C.  A multiple p-n junction structure obtained from as-grown Czochralski silicon crystals by heat treatment - Application to solar cells  A multiple p-n junction to solar cells  GAUL, H. H.  Long-term average performance benefits of parabolic trough improvements [SERI/TR-632-439] p0632 N80-28893  GAVELLOVA, I. P. Investigation of the characteristics of

GAVAIN, T. H.	GIEDT, W. H.
Estimated performance of an electrohydrodynamic	Effect of a heated atmosphere on the emittance of
power generator which utilizes a two-fluid ejector	black chrome solar collector pipe surfaces
[AIAA PAPER 80-1341] p0717 A80-44126	[UCRL-83506] p0631 H80-28877
GAY, B. C.  Cycle life studies of LiAl/FeS cells using BN felt	GIRSE, HJ. Plants for energy and material recycling
separators	p0682 A80-49991
p0763 A80-48189	GILBERT, J.
Optimization studies of lithium/iron sulfide cells	The potential of energy farming for transport
for electric vehicle applications	fuels in New Zealand, appendices
p0763 A80~48190	[PB80-154255] p0693 N80-28573
GAZIRV, U. KB. Experimental investigation of thermal	GILING, L. J.  The influence of grain size and dopant
characteristics of solar thermoelement block	concentration on the electrical properties of
p0611 A80-47157	polycrystalline silicon films
GAZLBY, C.	P0600 A80-46696
A quantitative evaluation of closed-cycle ocean	GILLARDRES, M.
thermal energy conversion (OTEC) technology in	Thin, high efficiency silicon solar cells p0658 N80-33885
central station applications [R-2595-DOR] p0749 N80-31885	GILLIAB, T. H.
GRE, B.	Removal of metals from coal ash
Long-term average performance benefits of	p0674 A80-48295
parabolic trough improvements	Assessment of current research and development in
[SERI/TR-632-439] p0632 880-28893	support of the U.S. coal liquefaction
GRIHER, J. C. Interactions between energy supply and	demonstration plants program p0677 A80-48428
transportation-related energy use, volume 1	GILLIGAN, J. G.
[PB80-185002] P0584 N80-31968	The Spheromak fusion reactor
GRIS, J. W.	p0733 A80-48495
Concentrating photovoltaics - A viable candidate	GILMORE, P. E.
for the next generation of Air Porce satellite	Perspectives on research on LNG vapor cloud
power systems p0614 A80-48209	dispersion p0590 N80-33593
GEJO, T. ;	GIRAMONTI, A. J.
Biogasification of municipal waste	Coal-fired fluid bed combustion augmented
p0683 A80-49997	compressed air energy storage systems
GBLB, S. W.	p0768 A80-48376
Design and flight performance of the Picneer Venus	GISBY, P. B.
Multiprobe and Orbiter solar arrays p0614 A80-48212	Biophotolytic H2 production using alginate-immobilized chloroplasts, enzymes and
GRORGE, J. F.	synthetic catalysts
Design of 40-MW grazing and moored OTEC	p0664 A80-50247
pilot/demonstration plants	GISSLEB, W.
p0727 A80-48348	Photoelectrochemical investigation on trigonal
GBORGE, H.	selenium film electrodes
Aqueous trifluoromethanesulfonic acid fuel cells [AD-A086579] p0745 N80-30905	p0610 A80-47139 gIURCA, V.
GERISCHER, H.	Investigation of the feasibility of methanol as an
Photoelectrochemical solar cells	automobile fuel
p0603 A80-46730	p0688 A80-52881
GERLAUGH, H. E.	GIVENS, R. W.
Cogeneration Technology Alternatives Study (CTAS).  Volume 2: Analytical approach	Approach to steady-state solvent composition in the SRC-I coal liquefaction process
[NASA-CR-159766] p0741 N80-28859	p0676 A80-48382
Cogeneration Technology Alternatives Study (CTAS).	GLASER, P. E.
Volume 3: Industrial processes	The benefits of solar power satellites
[NASA-CR-159767] p0749 N80-31870	p0598 A80-46387
Cogeneration Technology Alternatives Study (CTAS).	GLASS, H. C. A six kilowatt transformer-coupled converter for
Volume 4: Energy conversion systems [NASA-CR-159768] p0755 N80-33859	Space Shuttle solar power systems
GERWIH, H. J.	p0616 A80-48262
Field experience with solar concentrating	GLASS, R. B.
collector control systems	Instrumentation and process control development
[SAND-79-2044C] p0647 N80-31924 GEOTJES, A. J.	for in situ coal gasification [SAND-80-0482] p0692 N80-28562
A parametric study of 1000 HWe combined closed	Instrumentation and process control development
cycle MHD/system electrical power generating	for in situ coal gasification
plants	[SAND-80-1025] p0706 N80-31655
[TH-78-E-91] p0742 N80-28931	GLASSMAH, A. J.
GHOSH, A. K.	Some advantages of methane in an aircraft gas
. Theory of polycrystalline silicon solar cells - Effect of reduction in grain boundary	turbine [NASA-TM-81559] p0695 N80-29502
recombination states	GLENDENNING, I.
p0597 A80-46258	Large-scale electrical energy storage
Selenium heterostructure solar cells	p0761 A80-44241
p0598 A80-46259	GLOYNA, B. P.
GHOSH, S.	The outlook for nuclear power
The production of substitute natural gas and ' recyclables from municipal solid waste	[PB80-175755] p0579 N80-29156 GOCHBARG, I.
recyclables from municipal solid waste p0683 A80-49996	The Brazilian National Alcohol Programme
GIARDA, L.	p0687 A80-52855
On the effects of boron and phosphorus primary	GOETEBEEGER, A.
impurities in p-type silicon material for solar	Fluorescent planar concentrators - Performance and
cells	experimental results p0604 A80-46741
. p0606 A80-46758 GIBART, P.	GOPP, J. P.
Alsh as a candidate material for photovoltaic	Thermelectric materials for solar energy conversion
solar energy conversion	[AD-A084948] p0631 880-28869

CONAR, I. A.  Development of a falling-bed fusion for synthetic fuel production	p blanket system	GRAEBER, WD.  Methane formation during hydrogen g gas phase pyrolysis of selected a	
GOKHBAN, A.  Performance and applications potential turbine-pump with controlled flow	tial of a w rate	GRAEP, M. Q. H.  The influence of grain size and dop  concentration on the electrical p	ant
GOLDBERG, L. P. A state space analysis of a symmetr	p0768 A80-48375	polycrystalline silicon films GRAHAM, B. W.	p0600 A80-4669
free piston Stirling engine	p0734 A80-48498	Some advantages of methane in an ai turbine	rcraft gas
GOLDEN, 7. G. Refinery energy profile	-	[NASA-TH-81559] GRANNEL, S. J.	p0695 N80-2950
[ORO-5262-5-SUPPL] GOLDSHBERG, A. L.	p0577 N80-28857	Liquid-metal MHD for solar and coal component status	_
Some perspectives on the use of por for the electron-cyclotron plasma large tokamaks		GRANCEI, M. P. Upgrading of coal liquids for use a	p0724 A80-4822 s power
GOLDHAMMER, L. J.	p0738 A80-51038	generation fuels [EPRI-AF-1225]	p0699 N80-3054
Design and flight performance of the Multiprobe and Orbiter solar arra		GRANDJEAN, N. R. Analysis of the influence of geogra	
Qualification test results of the efficiency K6-3/4 and K7 silicon	p0614 A80-48212 production high	on parabolic trough solar collect [SAND-79-2032] GRAESTAPP, S. H., JR. Sodium-sulfur-aluminum chloride cel	or design p0631 N80-2887
GOLDSTRIB, B. C. Amorphous thin films for solar-cell	l applications	GRANT, M. A.	p0764 A80-4823
[DOE/ET-21074/4] GOLDSTRIE, D.	p0653 N80-32921	A problem posed by vapour-dominated systems	•
Life cycle cost analysis in resider and consumer appliances	•	GRAUMANE, D.	p0689 A80-5406
GOLDSTEIB, L., JR.	p0572 A80-48515	Energy conversion considerations of commercial fusion power plant	
Permentation ethanol as a petroleum	n substitute p0675 A80-48324	GRAVER, C.	p0733 A80-4849
GOLDSTRIB, S. A. Grad B focusing and deposition of a	relativistic	Analysis of the infrastructure for electric vehicles	
electron beams	p0717 A80-43972	[SAE PAPER 800112] GREAVES, B. J.	-
GOLLABALLI, S. R.  Combustion of drops and sprays of and its emulsions with water and		Design, engineering and evaluation a liners for slagging gasifiers [IITRI-M6043-5]	p0704 N80-3164
Volume 1: Experimental [PB80-178213]	p0698 #80-30470	GREAVER, S. C. Study of hydrogen-powered versus ba	•
Combustion of drops and sprays of and its emulsions with water and	no. 2 diesel oil	autonobiles [ATR-79 (7759) - 1-VOL-1]	p0665 N80-3127
Volume 2: Theoretical [PB80-178221]	p0698 N80-30471	GREEGOR, R. E. Solar thermophotovoltaic space powe	r system
On the influence of an interfacial Au/n-GaAs Schottky barrier solar		GREEN, L. A. Upgrading of coal liquids for use a	p0614 A80-4820
GOODALE, D. B.	p0608 A80-46784	generation fuels	p0699 H80-3054
Combustion performance of CVD silic thermionic diodes	con carbide	GREEN, N. A. Surface passivation of inversion la	•
GOODMAN, P. R., JR.	. p0732 A80-48473	solar cells	p0612 A80-4815
Sun Valley photovoltaic power proje [ALO-4281-1] GOODWIN, J. L.		GREEN, T. P. Transient response of a latent heat An analytical and experimental in	
Miniplant and bench studies of pres fluidized-bed coal combustion		[ASME PAPER 79-ET-36] GREEBBAUM, B.	p0761 A80-4572
[PB80-188121] GORADIA, C. The planar multijunction cell - Ar	p0712 N80-32999	Simultaneous photoproduction of hyd oxygen by photosynthesis [CONF-791072-32]	rogen and p0665 #80-3055
for earth and space	p0613 A80-48205	GREBUBERG, G.  Blectric vehicles - Finally a reali	-
GORDON, J. S. Economic performance model of APBC	•	GREENAN, P.	p0762 A80-4812
GORMAN, E. W.	p0571 A80-48199	Reduction of intensity variations of ideal flux concentrators	n the absorbers
Evaluation of cranking characterist commercially available hatteries	tics of between room	GREET, R. J.	p0598 A80-4645
temperature and -40 C [AD-A080614]	p0780 N80-33906	Maximum windmill efficiency	p0737 A80-5072
GORODETSKII, S. H. Design of a thermophotocell	p0610 390-#715#	GREGG, D. W. Solar retorting of oil shale	n0613 100 5040
GOTOR, S.	p0610 A80-47154	Solar coal gasification	p0613 A80-4819
Application of the energy concept trecovery system	p0574 A80-49934	Relative merits of alternate linking for underground coal gasification	
GOVARRTS, R. Influence of the double exponential	_	system design implications	p0688 A80-5296
efficiency and the yield of scree cells	en printed solar	Gasification of coal with solar ener [UCRL-84458]	
	p0606 A80-46764		

GREGORY, P. B	
High-efficiency AlGals/Gals concent	
cells by organometallic wapor pha	se epitaxy
GREBS, J. 2.	p0610 A80-46952
Solar retorting of oil shale	4
	p0613 A80-48198
GRETHER, D. F. Spectral character of solar and cir	_
Spectral character of solar and cir	cumsolar
radiation [LBL-10802]	p0653 N80-32916
GRIEST, W. H.	P0033 B00 32310
Possil fuels research matrix progra	
Environmental Protection Agency/D	epartment of
Energy Fossil Puels Research Mate	
[OBBL/TH-7346] GRIFFIB, O. E.	p0583 180-31632
OTEC cold water pipe design for pro	blems caused by
vortex-excited oscillations	
[AD-A084555]	p0741 N80-28867
GRINES, G.	
Hydrogen production from remote pow [BNI-27457]	pQ666 N80-32553
GRINES, P.	P#000 BOB 32333
Development of a bipolar Zn/Br2 bat	tery
	p0767 A80-48369
GRIMSHAW, J. A.	****
Degradation effects in silicon Scho solar cells	ttry partier
SOLUL COLLS	p0601 A80-46709
GRISWOLD, J.	
Closed cycle MHD power plant and re	trofit
optimization application	-0717 100-08221
GRITS, IU. A.	p0717 A80-44231
Matching of a radioisotopic thermoe	lectric
generator and an energy accumulat	or
	p0720 A80-46599
GRITTON, E. C.	-02016 00000
A quantitative evaluation of closed thermal energy conversion (OTEC)	technology in
central station applications	
[R-2595-DOE]	p0749 N80-31885
GROB, A.	
Improvement of phosphorus diffused	Silicon Solar
cells by laser treatment	p0606 A80-46763
GROB, J. J.	F
Improvement of phosphorus diffused	silicon solar
cells by laser treatment	0606 200 46363
GROSS, P. P.	p0606 A80-46763
An analysis of criteria for evaluat	ing proposals
for recovery of material and ener	gy from refuse
	p0574 A80-49931
GROSS, R. J.	
Numerical simulation of dual-media storage systems	ruermat energy
[ASHE PAPER 79-HT-35]	p0761 A80-45725
GROSSMAN, G.	
A packed bed dehumidifier/regenerat	
air conditioning with liquid desi	ccants
GRUDEN, D.	p0595 A80-45312
Reduction of fuel consumption by th	ermodynamic
optimization of the Otto motor:	
investigation of Otto diesel engi	
[EUR-6711-DE]	p0585 N80~32733
GRUVER, G. A. Advanced technology fuel cell progr	an
[EPRI-BM-1328]	p0752 N80-32877
GUARINI, G.	_
Gallium arsenide solar cells for ve concentration systems: Recent re	ry high
concentration systems: Recent re	sults, problems
and expectations [CISE-1518]	p0649 N80~31962
GUENTHER, D. A.	PA043 WOO.21205
Power extraction from deep ocean wa	ves employing a
novel wave energy device	
[ASME PAPER 80-PET-29]	p0720 A80-45275
Further analysis of a novel wave en	ergy device p0728 A80-48352
GURRIN, M. R.	PA150 VON-40335
Fossil fuels research matrix progra	
<ul> <li>Environmental Protection Agency/D</li> </ul>	epartment of
Energy Possil Fuels Research Mate	
[ORNL/TM-7346]	p0583 N80-31632

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GURRURE, E.

Kinetics and mechanisms of catalytic
hydroliquefaction and hydrogasification of lignite
        [FE-2702-10]
                                                          p0709 B80-32556
      N. J. A.
Selectivity improvement in the solvent refined
  CUIN.
        coal process. I - Detailed first-stage reaction studies - Coal mineral catalysis. II - Detailed
        second-stage reaction studies - Hydrotreating of coal liquids
 GUNN, R. D.
A water-influx model for UCG with spalling-enhanced drying
                                                          p0676 A80-48343
  GUPTA, A.
      Physical/chemical modeling for photovoltaic module life prediction
                                                          p0608 A80-46790
  GUPTA, R. G.
Cathode sheaths in potassium seeded MRD combustion
        plasmas
                                                          p0720 A80-46158
 GURSON, A. L.
High energy density composite flywheel program p0777 880-31892
  GURTIER, R. W.
Potential for improved silicon ribbon growth
through thermal environment control
                                                          p0601 A80-46704
  Thin film polycrystalline silicon solar cells [SAM-2207-T4] p0638 N8: GUSHUE, J. Feasibility of alternatives for surface
                                                          p0638 N80-29879
         utilization of coal wastes
         FE-3105-11
                                                          n0692 N80-28563
  GUSTAPSSON, A.
      Safety of wind energy conversion systems (WECS):
        Preliminary study [FFA-HU-2126]
                                                       p0742 N80-28933
  GUTKNBCHT, P. J.
      Porous media experience applicable to field
evaluation for compressed air energy storage
[PNL-3294] p0777 N80-32873
  GUTHAND, G.
      Nickel hydrogen cell development centered on
        positive electrodes with high capacity per unit area for load leveling and traction applications [BMFT-FB-T-79-74] p0776 N80-299
                                       H
  HAACK, B. B.
      A simulation model for wind electric systems
                                                          p0734 A80-48522
      Development of sodium sulfur batteries
  [BMFT-FB-T-79-60]
                                                          p0776 N80-29905
      Methodology for the comparative assessment of the
         Satellite Power System (SPS) and alternative
         technologies
         [ NASA-CB-163049]
                                                          p0750 880-31951
  HACKETT, C. B.
      Numerical simulation of dual-media thermal energy
        storage systems
[ASME PAPER 79-HT-35]
                                                         p0761 A80-45725
  HAFELÈ, N.
      The outlook for nuclear power [PB80-175755]
                                                          p0579 N80-29156
- HAGELY, J.
Photovoltaic institutional issues study
        [SAND-79-7054]
                                                          p0584 N80-31950
  HAGERSON, R. L.
The reversed-field pinch fusion reactor
                                                          p0733 A80-48492
 HABB, R.

Reduction of fuel consumption by thermodynamic optimization of the Otto motor: Comparative investigation of Otto diesel engines
[EUR-6711-DE] p0585 N80-
```

HAIGH, A. D.
A low cost solar simulator for testing

modules

photovoltaic terrestrial solar power cells and

Sodium-sulfur load leveling battery system

p0585 N80-32733

p0604 A80-46738

p0764 A80-48235

HALBLEIB, J. A., SR. Grad B focusing and deposition of relectron beams	lativistic	Satellite power systems (SPS) concept study. Volume 1: Executive summa	cy
Theoretical Bultiple beam overlap fro	p0717 A80-43972 om channel	[NASA-CR-3317] Satellite power systems (SPS) concer study. Volume 2, part 1: System	
transport of intense particle beam	s p0735 A80-49067	[NASA-CR-3318] Satellite Power Systems (SPS) concer	p0760 N80-3189
Relativistic-electron-beam/target in plasma channels	teraction in	study. Volume 6: In-depth elements [NASA-CR-3323]	t investigation p0651 N80-3285
HALB, R. W.	p0735 A80-49068	Satellite power system (SPS) concept study. Volume 3: Experimental ve	
Pilot study to select candidates for		definition	
Conservation research for the chemic [DOE/TIC-11114] HALES, C.	p0584 880-31940	[BASA-CR-3320] Satellite Power Systems (SPS) concep study. Volume 5: Special emphasi	
Design, engineering and evaluation of	f refractory	[ HASA-CR-3322 ]	p0651 N80-3286
liners for slagging gasifiers [IITRI-M6043-5]	p0704 N80-31640	Peasibility study: Puel cell cogene	ration in a
HALL, D. O. Biophotolytic H2 production using	•	<pre>vater pollution control facility, [DOE/ET-12431/T1-VOL-1]</pre>	volume 1 p0749 880-3192
alginate-immobilized chloroplasts,	enzymes and	EARNIPAE, A.	
synthetic catalysts	p0664 A80-50247	. Human comfort and auxiliary control in passive solar structures	considerations
World biomass - An overview	p0687 A80-52852	[LBL-10034] BANSON, J. A.	p0640 180-2990
HALL, B. S.	-	Solar/hydrogen systems assessment.	
Cogeneration Technology Alternatives Volume 2: Analytical approach	Study (CTAS).	Solar/hydrogen systems for the 198	5 - 2000 time
[NASA-CR-159766] HALL, J. L.	p0741 N80-28859	[NASA-CE-163392] HAO, B. R.	p0665 N80-2886
Economic and technical evaluation of	the Ames,	Assessment of Synthane mechanical eq	
Iowa solid waste recovery system	p0683 A80-50005	[HII-79TE5] HABDY, K. S.	p0710 N80-3257
HALL, B. B. Thin film /CdZn/S for solar cells		Vehicles testing of near-term batter	
	p0603 A80-46727	[SAE PAPER 800201] Electric and hybrid vehicle system r	p0773 180-4973 esearch and
Solar energy conversion through bioph	notolysis	development project, hybrid vehicl assessment. Volume 6: Cost analy	e potential sis
[SAB-0034-239-1-T2] HALLIGAN, A. S.	p0666 N80-31927	[COMS-4209-T1-VOL-6]	p0583 N80-3127
Pactors influencing the release of bo	oron from coal	An investigation of simultaneous hea	t and mass
ash materials	p0570 A80-45484	transfer in subbituminous coal	p0676 A80-4834
HALMANN, M.		HARMAN, B. D.	· .
Semiconductor-electrolyte solar cells photoelectrochemical reduction of c to organic fuel		Large-scale electrical energy storage HARPER, J. P.	p0761 180-4424
Photoreduction of carbon dioxide and	p0605 A80-46755	Assessment of Peruvian biofuel resou	rces and
formaldehyde and methanol on semico		alternatives [ANL/RES/TM-86]	p0708 B80-32547
materials	p0621 A80-48923	The potential of energy farming for	transport
HALS, P. Results from study of potential early		fuels in New Zealand [PB80-154248]	
MHD power plants and from recent E	P design work	The potential of energy farming for	p0693 N80-28572 transport
HAR, B. K.	p0717 A80-44107	fuels in New Zealand, appendices [PB80-154255]	p0693 880-2857
Use of gas from landfills for energy Operating experience at Palos Verde		HARRIS, J. S.	_
• •	p0683 A80-49999	20 kW gallium arsemide photovoltaic for central receiver concentrator	applications
A comparison of performance factors if	for passive	BARRIS, J. S., JR.	p0608 180-4679
solar heating	p0627 A80-52837	Advanced photovoltaic concentrator c [DSE-4042-T30]	ells p0643 B80-3094
HAMILTON, S.		Advanced photovoltaic concentrator c	ells
Coal gasification combined-cycle syst [EPRI-AP-1390]	em analysis p0713 N80-33601	[DSE-4042-T40] Gallium arsenide photovoltaic dense	p0645 H80-31904
HAMBE, A. B.	_	concentrator applications	_
Automotive storage of hydrogen using magnesium hydrides		[SAND-80-1569C] Gallium arsenide photovoltaic dense	p0654 N80-32936 array for
[SAH-1167-1] HAMMERII, H.	p0666 N80-31650 ·	concentrator applications [SAND-79-2270C]	p0655 N80-32938
Heavy water as a valuable by-product	of	HARRIS, M. J.	•
electrolytic hydrogen	p0661 A80-47665	Hanagement of a large, operational s	olar pond p0617 180-48363
HAMAK, J. J. Optimization studies of materials in	hydrogenated	HART, A. B. Large-scale electrical energy storag	•
amorphous silicon solar cells			p0761 A80-44241
Amorphous thin films for solar-cell a	p0602 180-46717 pplications	Relp processing and biomethanation t	echnology
	p0653 N80-32921		p0673 A80-48278
Rockwell Satellite Power System /SPS/ definition studies	<del>-</del>	Status of nuclear high temperature p development in the Pederal Republi	c of Germany
Satellite Power Systems (SPS) concept	p0623 A80-50953 definition	<pre>/coal gasification and long distan transport/</pre>	
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	p0759 #80-30900	÷	

HARTEOPP, G.	ERCK, B. B.
Ensured power supply and environmental protection	Upgrading of coal liquids for use as power
as elements of a provident social policy	generation fuels
p0575 A80-50825	[EPRI-AF-1225] p0699 N80-30547
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[BMFT-FB-T-79-60] p0776 N80-29905	BEIDLER, E.
HARVEY, R.	Pluorescent planar concentrators - Performance and
Conceptual design of RST: An rf-driven,	experimental results
steady-state Tokamak	p0604 A80-46741
[EPRI-AP-1351] p0751 N80-32233	HRIMBOCKEL, J. H.
HASKINS, R. J.	Gals solar cells for space applications
Sodium-sulfur load leveling battery system	p0613 A80-48203
p0764 A80-48235	HEINRICH, P.
HASSELRIIS, F.	The gasification of municipal and industrial waste
Start-up consideration in utility use of a refuse	in accordance with the SPW-FUNK-Process
derived fuel	p0682 A80-49979
p0673 180-48276	BRITS, A.
HASSETT, J. J.	Overview-absorption/Bankine solar cooling program
Sorption properties of sediments and	[LBL-10770] p0640 N80-29904
energy-related pollutants	HELDENBRAND, J. L.
[PB80-189574] p0589 N80-32997	Energy budget procedures and performance criteria
HASTINGS, K. B.	for energy conserving building illumination
LC-Fining of solvent refined coal - SRC-I and	systems
short contact time coal extracts	[PB80-184229] p0583 N80-31673
p0678 A80-48431	HELFRICH, J. H.
HATT, B. W.	The 100-kWp photovoltaic power system at Natural
Chemical fuel and raw material production by	Bridges National Monument p0615 A80-48227
thermal processing of refuse - Technology and economics	HELLEBREKERS, W. E.
p0684 A80-50010	Instability analysis in a nonequilibrium MHC
Refuse to fuels - An appraisal of thermal processes	generator
p0684 A80-50011	p0737 A80-50357
HATTENBURG, A. T.	BELLER, A.
Energy budget procedures and performance criteria	Sorption of moisture and methane on Fruitland coal
for energy conserving building illumination	p0676 A80-48346
systems	HELLER, R. A.
[PB80-184229] p0583 N80-31673	Thermal stress in a composite cylinder by finite
HATTORI, I.	difference technique
Performance characteristics of nonequilibrium MHD	[ASME PAPER 80-HT-107] p0612 A80-48036
generator with fully ionized seed and	HELM, R. W.
enlargement of stabilized region	Research and evaluation of biomass
p0739 A80-51465	resources/conversion/utilization systems
HAVEMANN, R.	(market/experimental analysis for development of
Why new technology to rerefine waste lubricating oil	a data base for a fuels from biomass model)
p0685 A80-50033	[DOE/RT-20611/11] p0700 N80-30552
HAVEN, K. P.	HELMS, P. W.
Environmental concerns for OTEC identified in the	The MOD-2 wind turbine
DOR OTEC Environmental Readiness Document	p0727 A80-48322
p0576 A80-53687	HENCH, T. L. Thin film (Cdan (C for color colle
HARRIES, S. L. Operation and maintenance cost data for	Thin film /CdZn/S for solar cells p0603 A80-46727
residential photovoltaic modules/panels	HENDERSON, B.
[NASA-CR-163585] p0650 N80-32855	Conceptual design of RST: An rf-driven,
HAUKINS, W. H.	steady-state Tokamak
The outlook for nuclear power	[EPRI-AP-1351] p0751 N80-32233
[PB80-175755] p0579 N80-29156	BREDRASON, R. W.
HAY, R. D.	Projected costs for electricity and products from
Residential photovoltaic flywheel storage system	OTEC facilities and plantships
performance and cost	p0728 A80-48349
p0768 A80-48377	BEUNE, R.
Residential photovoltaic flywheel storage system	Progress in the development of small flame heated
performance and cost	thermionic energy converters
[DOB/ET-20279/92] p0587 N80-32874	p0732 A80-48472
HAYDBU, J. A.	BENRY, C. R.
Refuse/sludge/hazardous waste co-disposal with	Limiting efficiencies of ideal single and multiple
energy recovery	energy gap terrestrial solar cells
p0684 A80-50020	p0609 A80-46951
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rotary separator turbine	solar cells in the backwall configuration
p0725 A80-48266	p0607 A80-46775
HAYS, R. A.	HERENDEEN, R. A.
Plasma-sprayed coatings for very high temperature	Energy analysis of geothermal-electric systems
solar absorbers	[COO-5085-4] p0584 N80-31915
[CONF-791021-3] p0631 N80-28875	BERIOF, J.
HEALY, H. C.	Preparation and analysis of Cu20 thin-film solar
Development of molten carbonate fuel cell power	cells
plant technology	p0607 A80-46781
[DOE/ET-15440/1] p0750 N80-31938	HERMAN, B. G.
HEBBLEWAITE, 1.	Methanol and methyl fuel catalyst
Air Force space power technology program	[FE-3177-5] p0708 N80-32472
p0782 N80-33468	
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HERMELEE, A.	HILL, B.
Reference energy systems as applied to regional	The spectral response of CdS:Cu/x/S solar cells
energy policy [BNL-26987] p0587 N80-32883	formed by dry barrier techniques p0597 A80-46251
HERRICE, C. S.  Heat storage capability of a rolling cylinder	Thin film cuprous sulphide-cadmium sulphide solar cells
using Glauber's salt p0773 A80-50945	p0628 A80-52862 HILL, B. W.
BERRING, B. Life cycle cost analysis in residential buildings	Highlights of the LLL Hoe Creek Ho. 3 underground coal gasification experiment
and consumer appliances p0572 A80-48515	p0670 A80-46606 Results from the Hoe Creek No. 3 underground coal
BERTEBERG, A.	gasification experiment
A new method of efficient heat transfer and storage at very high temperatures	p0675 A80-48340 HILTON, N. P.
. p0762 A80-48180	Cryogenic methane separation/catalytic
Overview of high efficiency power cycles for fusion p0728 A80-48358	hydrogasification process analysis [PE-3044-T6] p0690 B80-28548
BESKETS, K. W.  Destabilization of drift-universal eigenmodes by	RIBDLE, R. A. The consercial application of an OTEC Jacket
toroidal effects p0736 A80-49209	/tower/ design p0728 A80-48350
BBSS, R. W.	HIBHOV, B.
A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications	Experimental evidence of charge-exchange recombination of highly ionized iron and titanium in Princeton large torus
[R-2595-DOE] p0749 N80-31885	p0735 A80-48765
HESTER, J.  The photoklystron	HINRICHSEN, R. W.
p0623 A80-50956	MOD-2 wind turbine farm stability study [NASA-CE-165156] p0755 N80-33862
HERIG, G. H.	HINTON, B. S.
EBIC and capacitance measurements on Cu2S-CdS solar cells - Stability problems	Advanced combustion systems for stationary gas turbine engines. Volume 2: Bench scale
p0603 A80-46725	evaluation
(Integrated Cu2S-CdS thin film solar cell generator p0606 A80-46770	[PB80-175607] p0744 N80-29922 Advanced combustion systems for stationary gas
Determination of the spectral distribution of	turbine engines. Volume 4: Combustor
global radiation with a rapid spectral radiometer and its correlation with solar cell	verification testing, addendum [PB80-179849] p0698 N80-30313
efficiency	HIRSCHBEROFER, J. B.
p0608 A80-46789  BBUSOB, B. W.  Vegetation as an indicator of high wind velocity	<pre>Peasibility study: Fuel cell cogeneration in a    water pollution control facility, volume 1    [DOE/8T-12431/T1-VOL-1]</pre>
[RLC-2227-T24-79/1] p0694 N80-28996 HICKOI, C. B.	BHAT, J. G. Parametric study of prospective early commercial
Numerical simulation of dual-media thermal energy storage systems	OCMHD power plants /PSPEC/ p0717 A80-44106
[ASHE PAPER 79-HT-35] p0761 A80-45725	BO, C. T.
HIGASHI, R. R. Altos-model 8B wind turbine generator. Failure	Ion implanted solar cells from EFG silicon ribbons p0601 A80-46705
analysis [RFP-3035/3533/79-10] p0742 N80-28925 Altos-model 8B wind turbine generator.	BO, R. C. C. Nodal analysis of miniature cryogenic coolers p0734 A80-48500
Performance report	BOCEVAR, C. J.
[RPP-3033/3533/79-4] p0742 N80-28926 Sencenbaugh: Model 1000-14 wind turbine generator	Experimental investigation of the Trombe wall passive solar energy system
[RFP-3034/3533/79-5] p0746 N80-30931	p0627 A80-52833
Potential for conversion of refuse to energy in	HOCH, C. J.  Energy conservation in terminal airspace through
Ontario Canada and the Provincial Energy from Waste program	fuel consumption modeling [SAE PAPER 800745] p0573 A80-49695
p0681 A80-49546 HIGGINBOTHAM, J. L.	HORCKER, K. A. Simulation of the energy-industry-environment
Measurement of natural convection in air-cooled solar collectors	system for limited economic regions, using the example of Baden-Wuerttemberg. Part 1: Data,
p0627 A80-52834	model development adaptation [IKE-K-54-20-PT-1] p0589 N80-32974
DAM-ATOLL - A system for extracting energy from ocean waves	HORBIG, M. O. Internally cooled cabled superconductors. I
p0740 A80-53679	p0720 A80-45054
HIGGINSON, B. Automotive fuels from cellulose materials [NZERDC-49] p0710 H80-32571	BOFFRAB, A. L. TRACT -A small fusion reactor based on pear-term engineering
HIGHLEY, J.	p0733 A80-48493
Design and operation of fluidised bed industrial boilers and hot gas producers	HOPPNAH, A. R. Testing flat plate photovoltaic modules for
p0672 A80-48202	terrestrial environment p0608 A80-46788
HILL, F. B. Silicon web process development [NASA-CR-163386] p0631 N80-28864	BOFFMAN, H. W.
HILL, J. A.	Thermal energy storage for building heating and cooling applications
Establishment of parameters for production of long life nickel oxide electrodes for nickel-hydrogen	[ORNL/TH-7319] p0777 N80-32879 HOFFNAB, L. C.
cells	Study of gelled LNG
p0771 A80-48445	[DOB/BV-02057/T2] p0695 N80-29506
High concentration solar collector of the stepped	Overview of thick-film technology as applied to
spherical type - Optical design characteristics p0629 A80-53263	solar cells [SERI/TP-331-541] p0639 880-29895
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HOGBLAND, A. W.		HORNER, M. W.	
A synergistic solid waste to energy pro Phase 1 project concept	ject -	Development of high-temperature turbi technology to a technology readines	
p0	570 A80-47586	phase 2	
Hour, R. C. Himiplant and bench studies of pressuri	zed .	[PE-1806-86]  High-temperature turbine technology p	p0701 N80-30753
fluidized-bed coal combustion	. zeu	Overall Plant Design Description (O	
	712 N80-32999	coal-derived liquid	-0740 #00 20700
HOLLOWAY, P. H. Oxidation of electrodeposited black chr	one	[FE-1806-84] High-temperature turbine technology p	p0712 880-32728
selective solar absorber files		Overall Plant Design Description (O	
	656 B80-32953	coal gas electric power plant	-A762 NOA-33770
<b>EOLLSTEIN, B. J.</b> Research and development of an advanced	process	[PE-1806-83] HOROWITE, J. S.	p0752 N80-32729
for the conversion of coal to synthet		A thermodynamic analysis of a metal h	ydride heat
and other distillate fuels [FE-2306-38] p0	696 180-29513	pump	p0661 A80-48290
Research and development of an advanced	process .	HOTCHKISS, G. B.	-
for the conversion of coal to synthet and other distillate fuels	ic gasoline	Spectral effects on direct-insolation of five collector coatings	absorptance
	696 N80-29514		p0597 A80-45722
HOLMAN, A. S.		BOULBERG, W. A.	-
Annual Cycle Energy System (ACES) [ORBL/CON-42] p0	587 N80-32880	Heutral-beam energy and power require expanding-radius and full-bore star	
BOLBES, J. H.	307 800 32000	tokamak reactors	c up or
Assessment of current research and deve		HARY B B H	p0719 A80-44656
support of the U.S. coal liquefaction demonstration plants program		HOULE, B. H. Adapting geothermal energy to produce	ethanol for
. p0	677 180-48428	automotive fuel	
Safety studies on Li/SO2 cells. IV -		HOVERSON, S.	p0723 A80-48183
Investigations of alternate organic e	lectrolytes	Photocell heat engine solar power sys	tens
for improved safety	727 100-50507		p0612 A80-48179
HOLT, C. P.	737 180-50507	Nodal analysis of miniature cryogenic	coolers
Twenty years of experience with well-wa		-	p0734 A80-48500
heat pumps at Battelle's Columbus Lab	00rat0r1es 1733 A80-48481	BSIAO, K. H. Circulating fluidized bed boiler	•
HOLT, J. P.			p0672 A80-48201
Tests of a lightweight 200 kW MHD chann diffuser	el and	<b>High-efficiency InP homogenation sola</b>	r colle
	751 N80-32226		p0598 A80-46496
HOLTE, H. J.		BUANG, B. J.	
A classification scheme for the common hybrid heating and cooling systems	passive and	Similarity theory of solar water heat natural circulation	er with
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HOLZER, J. C. Performance of an inlet manifold for a	stratified	Gas distribution equipment in hydroge	n service -
storage tank		Phase II	
[ASHE PAPER 79-HT-67] PO	1597 A80-45728	HOB, K.	p0758 A80-48506
HOMSY, R. V.  The aluminum-air battery for electric v	ehicle	Methodology for the comparative asses	sment of the
propulsion		Satellite Power System (SPS) and al	ternative.
Aluminum air battery for electric vehic	768 A80-48373 :le propulsion	technologies [NASA-CR-163049]	p0750 N80-31951
[UCRL-84443] p0	779 N80-32941	HUBER, H. D.	-
HOMOTESCO, CA. Investigation of the feasibility of met	hanol ac an	The economics of aquifer storage of of for air conditioning	billed water
automobile fuel	.nanor as an		p0767 A80-48337
	688 A80-52881	HUDSON, W. R.	
HOWA, S.  The pressurized fluidized bed gasificat	ion of coal	Progress in space power technology	p0722 A80-48173
char		HUDSON, Z. P.	•
[BLL-RTS-12347] p0	1712 N80-33575	Advanced coal gasification system for power generation	electic
Environmental protection - Cooperation	versus	[FE-1514-97]	p0700 N80-30548
enactments	569 A80-43843	HUBTTINGER, E. J. Hethane formation during hydrogen gas	ification and
HOOVER, D. Q., JR.		gas phase pyrolysis of selected are	
Cell module and fuel conditioner	1700 NOA-21002	ROPP, J. R.	p0689 A80-54034
[NASA-CR-159888] p0 HOPKIBS, R. H.	1749 N80-31882	The case for fuel-cell-powered vehicl	.es
Silicon web process development		-	p0721 A80-47100
[NASA-CR-163386] p0	631 N80-28864	Combustion performance of CVD silicon	carhi de
Improvement in stacking structures of f	uel cells	thermionic diodes	
HORIGOER, T.	726 A80-48283	BUPPEAR, G. L.	p0732 A80-48473
Investigation of nitrate salts for sola	r latent	Municipal solid waste as an industria	l fuel
heat storage		•	p0670 A80-47589
HORH, P. L.	1595 A80-45316	HUGHBS, C. A. Liquid fuels production from biomass	
Blanket options for high-efficiency fus		[COO-4388-10]	p0708 N80-32545
HORNE, N. E.	1729 A80-48360	Some etching studies of the microstru	cture and
Solar thermophotovoltaic space power sy		composition of large aluminosilicat	e particles
ρĝ	614 A80-48208	in fly ash from coal-burning power	
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HULL, J. R. Computer simulation of solar pond th		1	
2011 D C	p0599 A80-46567	TAPARTER R T	•
Cassegrain solar concentrators for p	photovoltaics p0608 A80-46791	Contribution to the theory of the f induction-type MHD engine	ree-field
HULSE, R.	-	••	p0736 A80-49414
Experimental evidence of charge-exch	ange	Theory of an inductive free-field M	
recombination of highly ionized in			p0737 A80-50666
titanium in Princeton large torus		TAMBOTOUTT T D	po / 57 / 200 50000
creates in filecton large cores		IAMPOLSKII, I. R.	-1:-:-:
CHADDDA F P	p0735 A80-48765	Magnetic-pressure acceleration of c	
HUMPHREY, A. B.		liners by the pulse generators fo	r relativistic
Potential for biological conversion	of Diomass to	electron beams	
liquid fuels	A		p0736 A80-49098
	p0675 A80-48323	ICEKORSKI, B. P.	•
Hundrmare, A. S.		Development of molten carbonate fue	l cell.power
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[PB80-811441]	p0748 N80-30957	structure, and thermal stability	·
Synthetic fuels from municipal, indu			p0609 A80-46933
agricultural wastes. Citations fr		IGRA, O.	P0000 mod. 10000
data base		Preliminary results from the shroud	ed wind-turhine
[PB80-811375]	p0706 N80-31660	pilot plant	
Wind power. Citations from the NTIS		Prior Piune	p0722 A80-47525
[PB80-811458]	p0751 N80-31965	IKEGAMI, K.	P0.122 E00 4.525
Synthetic fuels from municipal, indu		Botating strength of laminated comp	ncito dicar
		motating sciences of institutes comp	
agricultural wastes. Citations fr		*****	p0762 180-47454
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Hydrogen use as a fuel. Citations f	rom the NIIS	energy convertor of sun's radiation	
data base			p0596 A80-45459
[PB80-813090]	p0667 N80-33607	ILES, P. A.	
State-of-the-art reviews and bibliog		Impact of terrestrial solar cell de	Actobment on
energy. Citations from the NTIS d [PB80-812886]	p0782 N80-33917	space applications	p0659 N80-33893
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[PB80-812894]	p0782 N80-33918	villages	•
Line-focus solar thermal energy tech		IORDANISHVILI, B. K.	p0616 A80-48232
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HUNN, B. D.		ISAACS, H. S.	
Applications of DOE-1 to passive sol		Fuel cell applied research: Blectro	ocatalysis and
commercial buildings - Preliminary		materials	
name :	p0626 A80-52831	[BNL-51053]	p0742 N80-28920
HUNT, A.		Puel cell applied research: Rlectro	ocatalysis and
Spectral character of solar and circ	umsolar	materials	-0700 000 00005
radiation	-0653 800 30046		p0744 N80-29885
[LBL-10802]	p0653 N80-32916	ISACHRIKO, V. I.	
HOST, D. F.		Matching of a radioisotopic thermoe.	
Department of Housing and Urban Deve		generator and an energy accumulate	
hot water initiative: Centralized			p0720 A80-46599
of technical tasks and system eval		ISAKSON, P.	
[PB80-189244]	p0656 N80-32961	Reporting format for thermal perform	
HUNT, L. P.		heating and cooling systems in bu	
Progress on the Dow Corning process	for	[ PB80-175375 ]	p0634 N80-29537
solar-grade silicon		ISANG, T. H. T.	
	P0600 A80-46699	Modeling of heat and mass transfer	luring coal
HUST, V. D.		block gasification	
Alcohol fuels for spaceship earth			. p0713 N80-33577
	p0686 A80-51953	ISHIDA, M.	
BUNTINGTON, J. P.	•	Biogasification of municipal waste	
Remote sensing and mineral explorati		<u> </u>	p0683 A80-49997
Proceedings of the Workshop, Banga	lore, India,	ISBIBABA, B.	_
May 29-June 9, 1979		Pinancing for energy resources devel	Lopment
	p0686 A80-51076	projects - Japanese experience	
HURAIB, P.			p0573 A80-49400
470-kW photovoltaic power system for	Saudi Arabia	ISHAHZHANOV, A.	
villages		Investigation of the service life of	
	p0616 A80-48232	mirrors on metal substrates at high	
HUTCHIBSON, C. P.			p0611 A80-47158
A methodology for the environmental	assessment of	ISON, J. W.	
advanced coal extraction systems		Interactions between energy supply	
[ NASA-CR-163570 ]	p0586 N80-32827	transportation-related energy use,	
HUTCHINSON, I. H.		[PB80-185002]	p0584 #80-31968
Observations of fluctuating onega su	b p emission	ITOH, H.	
in Alcator tokamaks	4544 - 44	Average chemical structure of mild	nydrogenolysis
	P0736 A80-49075	products of coals	
HOTH, U.			p0679 A80-49628
Prospects for using solar energy to		ITOB, K.	
materials-science furnaces in spac		Man-made molecular assemblies for en	
•	P0599 A80-46688	conversion from light into chemica	
			p0661 A80-46271

IULDASHRV, B. D.	•	
Some electric and photoelectric prope	rties	of
photodetectors based on epitaxial ]	ayers	
Si/x/Ge/1-x/ with diffused p-n junc		A80-47153
IUPPETS, P. B.	-	
Investigation of the characteristics		
electrochemical coatings for solar- collectors	·radiat	:10B
	p0611	A80-47164
IVES, B. D.		
Municipal refuse as a fuel for power		11101 1180-33950
IUAI, S.	P0 / 14	100-22-220
The producing mechanism, separative a		1.
characteristics of municipal refuse		A80-49539
INATA, K.	Pub/3	A00-49339
Average chemical structure of mild hy	drogei	olysis.
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TACECOE D T	•	
JACESON, B. L. Potential displacement of petroleum i	imports	: h⊽
solar energy technologies	Lapore	, 5,
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base for fuel cell total energy sys	stems a	ind
conventional building energy system	ıs	,
[ONNL/CCN-38]	p0754	N80-32960
JACOBS, B. Optimized grid patterns for Cu2S-CdS	solar	cells
of ormand Arms For onsp. ons		A80-49322
JACOBS, D.		
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JACOBS, P.	P0140	800-31222
Cost-effective ways to improve the fa	abricat	ion and
installation of solar heating and o	cooling	I
systems for residences [COO-4520-1]	p0632	N80-28902
JACOBSEE, S. R.	_	
Optimum OTEC design and sensitivity	nalysi	is using
geometric programming	n0741	A80-53688
JACOPP, P. S.	pu	54000
Energy/Environment 4: Proceedings of	the N	ational
Conference on the Interagency Energ B and D Program	I A\ E D A 1	.ronmen t
[PB80-177942]	p0581	N80-29928
JACQUEMIH, J. L.	_	
Hodel for the photovoltaic effect in solar cells in the backwall configu	Cu25-C	dS
Sold Cells in the DackBall Conling	D0607	A80-46775
JAHBIG, C. B.		
Over 50% efficiency achieved in gas t	turbine	system
using isothermal expansion	p0724	A80-48249
JAIH, S. C.	-	
Laboratory demonstration of self-created self-maintenance and self-correction	tion,	
saturated solar fonds	'II OE	-
		A80-48366
Temperature effects in silicon solar		300-E444F
JAMES, L. E.	•	A80-51115
Operation of multi-bandgap concentrat	or cel	ls with
a spectrum splitting filter		•
JAMES, R. K.	pu604	A80-46740
Joule heating effects in the electron	le wall	
boundary layer of MHD generators		
TARACET P 1	p0743	N80-29620
JANOSKI, B. J. Research and development of an advance	ed pro	cess
for the conversion of coal to synth	etic	asoline
and other distillate fuels		
[PE-2306-38] Research and development of an advance	p0696	N80-29513
for the conversion of coal to synth	etic o	asoline
and other distillate fuels		
[FE-2306-35]	p0696	N80-29514

Influence of the double exponential on the efficiency and the yield of screen printed solar cells JANZBN, A. P. Photoelectrochemical conversion using reaction-centre electrodes p0596 A80-45504 Biological solar cell [SERI/TP-623-656] p0639 N80-29893 JARASS, L. The potential and economics of wind energy - An investigation commissioned by the International Energy Agency for the Pederal Republic of Germany p0689 A80-54077 JABPABGAL, S. The power system p0743 N80-29387 JARVI, G. A. Process evaluation: Steam reforming of diesel fuel oil [AD-A087053] p0699 N80-30538 JARVIERE, P. O. Residential photovoltaic flywheel storage system performance and cost p0768 A80-48377 Ceramic dome receiver technology developments p0619 A80-48466 Residential photovoltaic flywheel storage system performance and cost [DOE/ET-20279/92] JASIONOUSKI, W. J. Gas distribution equipment in hydrogen service -Phase II p0758 A80-48506 JAUNOTTE, A. Setting fire to the whole forest p0569 A80-44780 JAYADEV, T. S.
Solar ponds for district heating and electricity generation p0618 A80-48367 Analysis of the application of thermogalvanic cells to the conversion of low grade heat to electricity p0729 A80-48390 Thermoelectric properties of bismuth-antimony thin films p0729 -A80-48391 Thermoelectric OTEC - An update p0731 A80-48436 Basic research needs and priorities in solar energy. Volume 1: Executive summary. Technology crosscuts for DOE [SERI/TR-351-358-VOL-1] p0645 N80-31898 Basic research needs and priorities in solar energy. Volume 2: Technology crosscuts for DOE [SERI/TR-351-358-VOL-2] r0645 N80-31899 Solar ponds and their applications [SERI/TP-733-617] p0655
JEMEINS, D. B.
Economic evaluation of the HIT process for p0655 N80-32947 manufacture of ethanol [DSE-3992-T1] p0705 N80-31647 JENKINS, T. P.
The fate and effects of crude oil spilled on subarctic permafrost terrain in interior Alaska [PB80-187305] p0585 N80-31984 Batteries for solar electricity p0605 A80-46747 JIMENES, R. Total and non-isotropic diffuse insolation on tilted surfaces p0599 A80-46571 JODY, B. J.
Industrial energy conservation with the natural gas-fueled molten carbonate fuel cell p0571 A80-48280 High-temperature water electrolysis for hydrogen production p0662 A80-48414 Economic and technical evaluation of the Ames, Iowa solid waste recovery system p0683 A80-50005

JABSSEES, R.

JOERGENSEN, O.	Passive solar heating of buildings with attached
Solar energy applications for dwelling: modelling	greenhouse
and simulation part	[DOE/CS-30242/2] p0649 N80-31955
[BUR-6681/I-EN] P0645 H80-31894	JOHES, W. J.
JOHNSON, D. L.	Peat as a fuel at the proposed Central Marine
Pulsed power accelerators for particle beam fusion	Power Company 600 MW plant, volume 1
[SAND-80-0550C] p0715 N80-34239	[PB80-175185] p0697 N80-29524
JOHNSON, I.	JOHER, R. J.
Methods of improving limestone utilization in	Combustible briquets from waste using the
fluidized-bed combustion	PINEDA/LOAS process
p0672 A80-48170	p0683 A80-50009
Hydration of 'spent' limestone and dolomite to	JOPLING, D. G.
enhance sulfation in fluidized-bed combustion	Introducing OTEC to mainland utilities
p0672_A80-48172	p0719 A80-44607
JOHESON, J.	JORGBUSEN, L. W.
Design of a photovoltaic system for a southwest	The feasibility of pellet re-fuelling of a fusion
all-electric residence	reactor
[SAHD-79-7056] p0637 H80-29876	p0719 A80-44661
JOHNSON, K. B.	JOSEPH, L. H.
Off-peak power for hydrogen production	The Department of Energy's major project coal
p0663 A80-48461	liquefaction program
JOHNSON, K. H.	p0677 A80-48427
Models for the photoelectrolytic decomposition of	JOUBERT, J. L.
water at semiconducting oxide anodes	Recent coal-oil mixture combustion tests at PETC
p0664 A80-50512	[DOE/PETC-TH-80/5] p0706 H80-31658
JOHNSON, L. A.	JOUSSB, D.
The fate and effects of crude oil spilled on	Schottky barriers on sputtered hydrogenated
subarctic permafrost terrain in interior Alaska	amorphous silicon - Photovoltaic properties and
[PB 80-187305] p0585 N80-31984	capacitance-voltage characteristics
JOHNSON, O. R.	p0602 A80-46720
Potential economics of large space based solar	JOYCE, P. J.
power stations	Multiphase reactor modeling for zinc chloride
p0617 A80-48354	catalyzed coal liquefaction
0000308 P* P*	[LBL-9870] p0703 N80-31628
Thin films of InP for photovoltaic energy conversion	JUANG, J. N.
[COO-3004-2] P0642 N80-30912	Dynamics and control of a continuum model for a
JOHESON, S.	solar power system
Investigation of the impurity tolerance of	[AIAA 80-1740] p0757 A80-45534
semicrystalline silicon solar cells silicon	JUDA, P.
impact program	Energy savings by means of fuel cell electrodes in
[DOE/CH-00178/T2] p0654 N80-32934	electro-chemical industries
JOHNSON, T. R.	[COO-4881-12] p0745 N80-30902
Development of steam generator components for	JUSTI, B. W.
open-cycle MHD	The influence of contact pressure on the
p0723 A80-48186	
open-cycle MHD p0723 A80-48186	performance of supported gas diffusion
JORESTOR, A. M.	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells
JORNSTON, A. M. Ammonia/water absorption cycles with relatively	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459
JOHNSTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459 JUSTUS, C. G.
JOHNSTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures p0625 A80-51682	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459 JUSTUS, C. G. Analytical studies of wind turbine turning
JOHNSTON, A. M.; Ammonia/water absorption cycles with relatively high generator temperatures p0625 A80-51682 JOHNS, B.	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459 JUSTUS, C. G. Analytical studies of wind turbine turning characteristics
JOHNSTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures p0625 A80-51682  JOHNS, B. The combined firing of coal and waste derived fuel	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459 JUSTUS, C. G. Analytical studies of wind turbine turning
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHNS, B.  The combined firing of coal and waste derived fuel in steam raising plant	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 M80-32951
JOHNSTON, A. M.  Anmonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459 JUSTUS, C. G. Analytical studies of wind turbine turning characteristics
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHNS, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHNS, B. W.	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [BLO-2439-79/3] p0753 M80-32951
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHNS, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHNS, B. W.  A solar power system / Prometheus/ to provide 100	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 N80-32951
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. W.  A solar power system / Prometheus/ to provide 100 per cent of low-grade heat needs	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H60-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHNS, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHNS, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHNS, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHNS, B. W.  A solar power system / Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHNS, D.	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 N80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHNS, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHNS, B. W.  A solar power system / Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHNS, D.  Power extraction from deep ocean waves employing a	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRB, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHNS, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHNS, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHNS, D.  Power extraction from deep ocean waves employing a novel wave energy device	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 B80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHRS, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHRS, B. H.  A solar power system / Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHRS, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASER PAPER 80-PET-29]  p0720 A80-45275	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. W.  A solar power system / Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASME PAPEE 80-PET-29] p0720 A80-45275 Further analysis of a novel wave energy device	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [ELO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KALBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array
JOHESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASHE PAPER 80-PET-29]  Purther analysis of a novel wave energy device p0728 A80-48352	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KAELBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [MASA-CR-163583] p0651 H80-32857
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. H.  A solar power system / Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASHE PAPPER 80-PET-29] p0720 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JOHES, D. G.	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [BLO-2439-79/3] p0753 M80-32951  K  KACHRB, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KAELBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [MASA-CR-163583] p0651 M80-32857
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  JOHNS, B.  The combined firing of coal and waste derived fuel in steam raising plant  PO681 A80-49956  JOHNS, B. W.  A solar power system / Prometheus/ to provide 100 per cent of low-grade heat needs  JOHNS, D.  Power extraction from deep ocean waves employing a novel wave energy device  [ASME PAPER 80-PET-29]  Purther analysis of a novel wave energy device p0728 A80-48352  JOHNS, D. G.  Catalytic hydrogenation of Liddell bituminous coal	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KAELBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells
JORESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASME PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a lovel wave energy device p0728 A80-48352  JORES, D. G.  Catalytic hydrogenation of Liddell bituminous coal Effects of process variables on coal	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283
JOHESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASME PAPER 80-PET-29] Further analysis of a novel wave energy device p0728 A80-48352  JOHES, D. G.  Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [BLO-2439-79/3] p0753 N80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KAELBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CE-163583] p0651 N80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283
JOHNSTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. H.  A solar power system / Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASHE PAPER 80-PET-29] p0720 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JOHES, D. G.  Catalytic hydrogenation of Liddell bituminous coal effects of process variables on coal dissolution in batch autoclaves	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KAELBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 B80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHH, D. R. The CS/R advanced SNG hydrogasification process
JORESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASME PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G.  Catalytic hydrogenation of Liddell bituminous coal Effects of process variables on coal dissolution in batch autoclaves  JORES, D. E.	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHW, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292
JOHESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASME PAPER 80-PET-29] PUTTHER analysis of a novel wave energy device p0728 A80-48352  JOHES, D. G.  Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves  p0679 A80-49627  JOHES, D. W. Regenerative flywheel energy storage system	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRB, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHN, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292
JOHESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASHE PAPER 80-PET-29] Further analysis of a novel wave energy device p0728 A80-45275 Further analysis of a novel wave energy device p0728 A80-48352  JOHES, D. G.  Catalytic hydrogenation of Liddell bituminous coal dissolution in batch autoclaves  p0679 A80-49627  JOHES, D. H.  Regenerative flywheel energy storage system [UCRL-13982-RET-1] p0775 N80-28884	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KAELBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHH, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAIHDL, K. The first realistic solar energy project
JORESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASME PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G.  Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves  JORES, D. W.  Regenerative flywheel energy storage system [UCRL-13982-REV-1]  JORES, G. J.	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHM, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAIHDL, K. The first realistic solar energy project
JOHESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASHE PAPER 80-PET-29] p0720 A80-45275 Further analysis of a novel wave energy device p0728 A80-48352  JOHES, D. G.  Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves  p0679 A80-49627  JOHES, D. W.  Regenerative flywheel energy storage system [UCRL-13982-REV-1] p0775 N80-28884  JOHES, G. J. The design of photovoltaic systems for residential	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRB, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHN, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994
JORESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASRE PAPER 80-PET-29] Further analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G.  Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves p0679 A80-49627  JORES, D. H. Regenerative flywheel energy storage system [UCRL-13982-REV-1] p0775 N80-28884  JORES, G. J.  The design of photovoltaic systems for residential applications in the United States	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 B80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHB, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging
JORESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASRE PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G.  Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves  JORES, D. W.  Regenerative flywheel energy storage system [UCRL-13982-REV-1]  JORES, G. J.  The design of photovoltaic systems for residential applications in the United States	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHM, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles
JORESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D.  Power extraction from deer ocean waves employing a novel wave energy device [ASME PAPEE 80-PET-29] p0720 A80-45275 Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G.  Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves  p0679 A80-49627  JORES, D. W.  Regenerative flywheel energy storage system [UCRL-13982-REV-1] p0775 N80-28884  JORES, G. J.  The design of photovoltaic systems for residential applications in the United States  p0602 A80-46716 Photovoltaic central station applications - Status	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRB, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHN, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729
JORESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B. The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D. Power extraction from deep ocean waves employing a novel wave energy device [ASRE PAPER 80-PET-29] Further analysis of a novel wave energy device p0720 A80-45275 Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G. Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves p0679 A80-49627  JORES, D. W. Regenerative flywheel energy storage system [UCRL-13982-RET-1] p0775 N80-28884  JORES, G. J. The design of photovoltaic systems for residential applications in the United States  p0602 A80-46716 Photovoltaic central station applications - Status and prospects	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H60-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 B80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHB, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAIBDL, K. The first realistic solar energy project p0758 A80-50994  KAISEE, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUNDE, K. J.
JORESTON, A. M.  Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B.  The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W.  A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D.  Power extraction from deep ocean waves employing a novel wave energy device [ASHE PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G.  Catalytic hydrogenation of Liddell bituminous coal Effects of process variables on coal dissolution in batch autoclaves  JORES, D. W.  Regenerative flywheel energy storage system [UCRL-13982-REV-1]  JORES, G. J.  The design of photovoltaic systems for residential applications in the United States  p0602 A80-46716 Photovoltaic central station applications - Status and prospects	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHM, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAIHDL, K. The first realistic solar energy project p0758 A80-50994  KAISEE, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUNDE, K. J. Chemistry of lignite liquefaction
JOHESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JOHES, B. The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JOHES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D. Power extraction from deer ocean waves employing a novel wave energy device [ASHE PAPEE 80-PET-29] p0720 A80-45275 Further analysis of a novel wave energy device p0728 A80-48352  JOHES, D. G. Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves  p0679 A80-49627  JOHES, D. W. Regenerative flywheel energy storage system [UCRL-13982-REV-1] p0775 N80-28884  JOHES, G. J. The design of photovoltaic systems for residential applications in the United States  P0602 A80-46716 Photovoltaic central station applications - Status and prospects  P0615 A80-48231 Photovoltaic systems and applications perspective	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHN, D. R. The CS/R advanced SHG hydrogasification process p0674 A80-48292  KAIHDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUHDE, K. J. Chemistry of lignite liquefaction [FE-2211-11]
JORESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B. The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D. Power extraction from deep ocean waves employing a novel wave energy device [ASRE PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G. Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves p0679 A80-49627  JORES, D. W. Regenerative flywheel energy storage system [UCRI-13982-REV-1] p0775 N80-28884  JORES, G. J. The design of photovoltaic systems for residential applications in the United States  p0602 A80-46716 Photovoltaic central station applications - Status and prospects  Photovoltaic systems and applications perspective [SAND-80-0926C] p0582 N80-30923	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 N80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHB, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUNDE, K. J. Chemistry of lignite liquefaction [FE-2211-11] p0704 880-31642
JORESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B. The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D. Power extraction from deep ocean waves employing a novel wave energy device [ASHE PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G. Catalytic hydrogenation of Liddell bituminous coal Effects of process variables on coal dissolution in batch autoclaves  JORES, D. W. Regenerative flywheel energy storage system [UCRL-13982-REV-1] JORES, G. J. The design of photovoltaic systems for residential applications in the United States  p0602 A80-46716 Photovoltaic central station applications - Status and prospects  p0615 A80-48231 Photovoltaic systems and applications perspective [SAND-80-0926C] p0582 N80-30923  JORES, G., II	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHM, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUHDE, K. J. Chemistry of lignite liquefaction [FE-2211-11]  KAHARH, G. S. Development of space-qualified GaAs solar cells
JOHESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  JOHES, B. The combined firing of coal and waste derived fuel in steam raising plant  JOHES, B. W.  A solar power system / Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JOHES, D. Power extraction from deer ocean waves employing a novel wave energy device [ASHE PAPEE 80-PET-29] Further analysis of a novel wave energy device p0728 A80-48352  JOHES, D. G. Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves  p0679 A80-49627  JOHES, D. W. Regenerative flywheel energy storage system [UCRL-13982-REV-1] JOHES, G. J. The design of photovoltaic systems for residential applications in the United States  P0602 A80-46716 Photovoltaic central station applications - Status and prospects  p0615 A80-48231 Photovoltaic systems and applications perspective [SAND-80-0926C] JOHES, G., II Organic photochemical storage of solar energy	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHH, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUNDE, K. J. Chemistry of lignite liquefaction [FE-2211-11] p0704 B80-31642
JORESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B. The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D. Power extraction from deep ocean waves employing a novel wave energy device [ASHE PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G. Catalytic hydrogenation of Liddell bituminous coal Effects of process variables on coal dissolution in batch autoclaves  JORES, D. W. Regenerative flywheel energy storage system [UCRL-13982-REV-1] JORES, G. J. The design of photovoltaic systems for residential applications in the United States  p0602 A80-46716 Photovoltaic central station applications - Status and prospects  p0615 A80-48231 Photovoltaic systems and applications perspective [SAND-80-0926C] p0582 N80-30923  JORES, G., II	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 B80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHB, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUNDE, E. J. Chemistry of lignite liquefaction [FE-2211-11] p0704 B80-31642  KAHHOLO, E. S. Development of space-qualified GaAs solar cells p0658 N80-33888
JORESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B. The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D. Power extraction from deep ocean waves employing a novel wave energy device [ASRE PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G. Catalytic hydrogenation of Liddell bituminous coal Effects of process variables on coal dissolution in batch autoclaves  JORES, D. W. Regenerative flywheel energy storage system [UCRL-13982-REV-1] JORES, G. J. The design of photovoltaic systems for residential applications in the United States  p0602 A80-46716 Photovoltaic central station applications - Status and prospects  p0615 A80-48231 Photovoltaic systems and applications perspective [SAND-80-0926C] JORES, G., II Organic photochemical storage of solar energy [COO-4380-3] JORES, R. W.	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHN, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUHDE, K. J. Chemistry of lignite liquefaction [FE-2211-11] p0704 E80-31642  KAMATH, G. S. Development of space-qualified GaAs solar cells p0658 N80-33888
JORESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  JORES, B.  The combined firing of coal and waste derived fuel in steam raising plant  PO681 A80-49956  JORES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  Power extraction from deep ocean waves employing a novel wave energy device [ASRE PAPER 80-PET-29] Further analysis of a novel wave energy device PO728 A80-48352  JORES, D. G. Catalytic hydrogenation of Liddell bituminous coal Effects of process variables on coal dissolution in batch autoclaves  PO679 A80-49627  JORES, D. W. Regenerative flywheel energy storage system [UCRL-13982-REV-1] PO775 N80-28884  JORES, G. J. The design of photovoltaic systems for residential applications in the United States  PO602 A80-46716 Photovoltaic central station applications - Status and prospects  Photovoltaic systems and applications perspective [SAND-80-0926C] PO582 N80-30923  JORES, G. II Organic photochemical storage of solar energy [CO0-4380-3]	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 B80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHB, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUNDE, E. J. Chemistry of lignite liquefaction [FE-2211-11] p0704 B80-31642  KAHHOLO, E. S. Development of space-qualified GaAs solar cells p0658 N80-33888
JORESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B. The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D. Power extraction from deep ocean waves employing a novel wave energy device [ASRE PAPER 80-PET-29] Purther analysis of a novel wave energy device p0728 A80-45275  Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G. Catalytic hydrogenation of Liddell bituminous coal Effects of process variables on coal dissolution in batch autoclaves  JORES, D. W. Regenerative flywheel energy storage system [UCRL-13982-REV-1] JORES, G. J. The design of photovoltaic systems for residential applications in the United States  p0602 A80-46716 Photovoltaic central station applications - Status and prospects  p0615 A80-48231 Photovoltaic systems and applications perspective [SAND-80-0926C] JORES, G., II Organic photochemical storage of solar energy [COO-4380-3] JORES, R. W.	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHM, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAINDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUNDE, K. J. Chemistry of lignite liquefaction [FZ-2211-11] p0704 E80-31642  KANATH, G. S. Development of space-qualified GaAs solar cells p0658 N80-33888  KANIBOTO, M. Investigation of mitrate salts for solar latent
JOHESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  JOHES, B. The combined firing of coal and waste derived fuel in steam raising plant  PO681 A80-49956  JOHES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  PO624 A80-50968  JOHES, D. Power extraction from deer ocean waves employing a novel wave energy device [ASHE PAPEE 80-PET-29] Purther analysis of a novel wave energy device [ASHE PAPEE 80-PET-29] Further analysis of a novel wave energy device PO728 A80-48352  JOHES, D. G. Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves  PO679 A80-49627  JOHES, D. W. Regenerative flywheel energy storage system [UCRL-13982-RET-1] PO775 N80-28884  JOHES, G. J. The design of photovoltaic systems for residential applications in the United States  PO602 A80-46716 Photovoltaic central station applications - Status and prospects  PO615 A80-48231 Photovoltaic systems and applications perspective [SAND-80-0926C] PO582 N80-30923 JOHES, G., II Organic photochemical storage of solar energy [CO0-4380-3] Performance estimates for attached sunspace	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 H80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHN, D. R. The CS/R advanced SHG hydrogasification process p0674 A80-48292  KAIHDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUHDE, K. J. Chemistry of lignite liquefaction [FZ-2211-11] p0704 E80-31642  KAMATH. G. S. Development of space-qualified GaAs solar cells p0658 N80-33888  KAHIBOTO, H. Investigation of mitrate salts for solar latent heat storage
JORESTON, A. M. Ammonia/water absorption cycles with relatively high generator temperatures  p0625 A80-51682  JORES, B. The combined firing of coal and waste derived fuel in steam raising plant  p0681 A80-49956  JORES, B. W. A solar power system /Prometheus/ to provide 100 per cent of low-grade heat needs  p0624 A80-50968  JORES, D. Power extraction from deep ocean waves employing a novel wave energy device [ASRE PAPER 80-PET-29] Further analysis of a novel wave energy device p0728 A80-48352  JORES, D. G. Catalytic hydrogenation of Liddell bituminous coal - Effects of process variables on coal dissolution in batch autoclaves  p0679 A80-49627  JORES, D. W. Regenerative flywheel energy storage system [UCRI-13982-REV-1] p0775 N80-28884  JORES, G. J. The design of photovoltaic systems for residential applications in the United States  p0602 A80-46716 Photovoltaic central station applications - Status and prospects  Photovoltaic systems and applications perspective [SAND-80-0926C] p0582 N80-30923  JORES, G. II Organic photochemical storage of solar energy [COO-4380-3] PORSS, R. W. Performance estimates for attached sunspace passive solar heated buildings	performance of supported gas diffusion electrodes in alkaline H2-O2-fuel cells p0739 A80-51459  JUSTUS, C. G. Analytical studies of wind turbine turning characteristics [RLO-2439-79/3] p0753 H80-32951  K  KACHRE, K. S. D. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area  p0570 A80-46150  KABLBLE, D. H. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 B80-32857  KAHARA, T. Improvement in stacking structures of fuel cells p0726 A80-48283  KAHB, D. R. The CS/R advanced SNG hydrogasification process p0674 A80-48292  KAIBDL, K. The first realistic solar energy project p0758 A80-50994  KAISER, R. Analysis of the infrastructure for recharging electric vehicles [SAE PAPER 800112] p0773 A80-49729  KALBUNDE, E. J. Chemistry of lignite liquefaction [FE-2211-11] p0704 B80-31642  KAHHOTO, M. Investigation of mitrate salts for solar latent heat storage

		••	4
KAMMBBUD, B.	•	KAUAI, T.	
Human comfort and auxiliary control of in passive solar structures	considerations	Conversion of carbohydrate into hydr photocatalytic process	ogen fuel by a
[LBL-10034]	p0640 N80-29903		p0661 A80-44598
A classification scheme for the common hybrid heating and cooling systems		KANANA, B.  Improvement in stacking structures of	f fuel cells p0726 180-48283
KAEOGAWA, H.	p0627 A80-52835	EAYE, W. G. Design and operation of fluidised be	-
OTEC research in Japan	p0718 A80-44600	boilers and hot gas producers	
KAMPWIRTH, R. T.		KRAIRES, D. L.	p0672 180-48202
Structure of amorphous silicon and s	p0599 A80-46647	Advanced coal gasification system for power generation [FE-1514-97]	p0700 #80-30548
Magnetoplasma compressor with an exp. magnetic power generator	losion-driven	KEARNEY, D.	· -'
	p0717 A80-44185	End-use matching of solar energy sys	p0624 A80-51208
KANE, E. W. Energy choices and environmental con-	straints p0576 A80-51933	Long-term average performance benefi parabolic trough improvements [SERI/TR-632-439]	.ts or p0632 N80-28893
KANTHIMATHINATHAN, T The power system	;	KEAVENT, D.	· · · · · · · · · · · · · · · · · · ·
	p0743 N80-29387	Analysis, design and realization of photovoltaic generator	* •
KANTEER, E. Development of a bipolar Zn/Br2 batt	ery p0767 A80-48369	KRIERR, C.	p0605 180-46745
KAPLAN, P. Nave drift forces on OTEC platforms	P0.01 W00-40303	Absorption refrigeration machine dri heat [BDR-6748-EN]	p0646 #80-31914
	p0740 A80-53676	KELLER, J. G.	
MAPLOW, R. Photovoltaic conversion - Recent pro	gress in solid		p0723 A80-48184
state solar cells KARIYAWASAM, H. C.	p0620 A80-48790	Heat pumps in low temperature application [CONF-800806-7] KELLER, W. R.	p0711 180-32699
Evaluation of hydropower potential is	n a river basin p0755 N80-33856	Assessment of environmental control for energy storage systems, 1979	technologies
KASHIWA, B. A. An investigation of simultaneous hea	•		p0588 N80-32973
transfer in subbituminous coal	p0676 180-48344	Climate and energy: A comparative a the Satellite Power System (SPS) a	
KASSING, D. Satellite power systems: Status and	planned	energy technologies [DOE/ER-0050]	p0581 N80-30914
activities	p0760 N80-33904	RELLY, C. E. REG power source for the Internation	al Solar Polar
KASTEN, P. R. High-temperature gas-cooled reactors	and process	Mission	p0727 A80-48305
heat	p0758 A80-48312	KELLY, R. H. Coal gasification/gas cleanup test f	
KASTHER, S. O.	-	Volume 1. Description and operati	.on
Use of generalized population ratios XV line intensities and linewidths electron densities		[PB80-188378] KENNEY, D. D. Analysis of a passive heat pipe cool	p0707 N80-31990
	p0735 A80-48763	photovoltaic receiver	
Advanced coal gasification system for	r,electric	[SAND-80-7011] KENNEY, N. D.	
	p0700 N80-30548	The 1980 technology status of the Dy Power System	
KATZ, J. L. Condensation processes in coal combu	stion products	KENNISH, W.	p0725 A80-48255
[DOE/EE-10456/1] KATS, E-	p0708 N80-32473	Reporting format for thermal perform heating and cooling systems in bui	
Development of molten carbonate fuel plant technology	cell power	[PB80-175375] KENTFIELD, J. A. C.	p0634 N80-29537
[DOE/ET-15440/1] KATZER, J. R.	p0750 N80-31938	Benefits arising from the use of pne transmittal in wind-power systems	umatic energy
Development of unique catalysts for	. lieuide		p0757 A80-48271
hydrodenitrogenation of coal-derive [FB-3297-1]	p0690 N80-28482	RERB, B. C., JR. Residential photovoltaic systems	
Development of unique catalysts for hydrodenitrogenation of coal-derive	ed liquids	KERRISK, J. P.	p0615 A80-48228
[FE-3297-2] Development of unique catalysts for	p0690 N80-28545	Applications of DOE-1 to passive sol commercial buildings - Preliminary	results
hydrodenitrogenation of coal-derive	ed 119414s p0690 #80-28546	ERRUIS, W. J.	p0626 A80-52831
New approach to electrode current co.	llection for	Fuel cell systems for vehicular appl	p0736 A80-49720
Lial/iron sulfide cells KAUPERT, A. W.	p0763 A60-48191	RESSLER, R.  Results from study of potential earl	
A review of advanced vehicular diese.		MHD power plants and from recent R	p0717 A80-44107
development programs which have po application to stationary diesel p	ower plants	Open-cycle MHD generator channel dev	P0723 A80-48185
[AD-A085601] KAWABATA, J.	p0743 N80-29738	READIKOV, H. K. Investigation of high-voltage hetero	
The fluidized bed gasification of co- [BLL-BTS-12346]	al char p0712 180-33576		p0611_A80-47163
•			

KHAHIDULLIH, P. A.			
		KISSBL, G.	
Comparative analysis of the basic comb		Improved alkaline hydrogen/air fuel	cells for
characteristics of some heavy hydroc		transportation applications.	p0726 A80-48282
in application to aircraft gas turbi.	0721 A80-47424	KISSEL, S. E.	P0120 ECO 40202
KHANDOVLETOV, S.		Observations of fluctuating omega su	b p emission
Metallic thermoelectric materials in s	olar	in Alcator tokamaks	•
thermoelectric generators		•	p0736 A80-49075
P	0610 A80-47152	KITAMI, S.	
KHATAHOV, S. O.		The advantages of using an incinerat	
Investigation of temperature regime of		system to control the emission of	
single-story house with solar heating		and steam generation in refuse inc	
	0611 A80-47162	FIOTIER T	p0574 A80-49961
KHATTAK, C. P.		KJOLLER, J. Bydrogen storage in magnesium powder	
Low-cost, high-efficiency silicon by h exchanger method and fixed abrasive		nydrogen scorage in magnesian powder	p0664 A80-50623
technique	211111	KLASS, D. L.	P0004 1200 500,55
	0600 A80-46700	The production of substitute natural	gas and
KHEMANI, L. T.	200 10110	recyclables from municipal solid w	
A study of the gaseous and particulate	pollutants		p0683 A80-49996
in the environment of a thermal powe		Research, development, and commercia	lization .
project area	_	activities on biomass energy in th	e United States
	0570 A80-46150		p0687 A80-52857
KHIZHNIAK, V. I.	_	KLAUSING, T. A.	
Some perspectives on the use of powerf	ul gyrotrons	Design study of steel V-Belt CVT for	electric
for the electron-cyclotron plasma he	ating in	Vehicles	-0777 700 30000
large tokamaks	0730 NOV E4030	[NASA-CR-159845]	p0777 880-32299
KHOSHAIR, B.	0738 A80-51038	Possible means of cutting energy cos	te and carring
470-kW photovoltaic power system for S	andi krahia	primary energy in waste water puri	
villages	add Midble	prizary energy in maste wheel puri	p0575 A80-50818
	0616 A80-48232	KLBEMAN, P. T.	<b>F</b> 1010 211 21111
KHOZHAIBOV, A. I.		Simulation model for assessing build	ing
Piston type magnetohydrodynamic motor		energy-conservation policies	
	0739 A80-52556	[BNL-27802]	p0587 N80-32901
KHRISTOFOROV, B. D.		KLRIB, F. P.	
Magnetoplasma compressor with an explo-	sion-driven	Dynamic simulation and development o	
magnetic power generator		strategy for a distributed, concen	trating solar
	0717 A80-44185	collector field	
KILAR, L. A.	<u>.</u>		p0629_180-53571
Design study and economic assessment of		KLBIN, M. G.	
offshore wind energy conversion syst		Hybrid lithium/nickel-zinc large mis	site dround
application. Volume 1: Executive s [WASH-2330-78/4-VOL-1] p		power source	p0772 A80-48489
RILE, N. G.	0746 N80-30930	KLRINSCHMAGER, E.	p0//2 A00-40403
Feasibility study: Fuel cell cogenera	tion in a	Development of sodium sulfur batteri	es ·
water pollution control facility, vo			p0776 N80-29905
	0749 N80-31922	KLETT, A. G.	•
		Posnibility otudes   Pool coll cocono	
KILGREN, L. M.		Peasibility study: Fuel cell cogene	ration in a
Interface recombination and junction f	ield studies	water pollution control facility,	
Interface recombination and junction f in the Cu2S-CdS solar cell		water pollution control facility, [DOE/ET-12431/T1-VOL-1]	
Interface recombination and junction f in the Cu2S-CdS solar cell P	ield studies 0603 A80-46724	water pollution control facility, [DOE/ET-12431/T1-VOL-1] KLEYE, D.	volume 1 p0749 N80-31922
Interface recombination and junction f in the Cu25-CdS solar cell KIM, D. B.	0603 A80-46724	water pollution control facility, [DOE/ET-12431/T1-VOL-1] KLEYS, D. A parametric study of 1000 MWe combi	Volume 1 p0749 N80-31922 ned closed
Interface recombination and junction f in the Cu25-CdS solar cell  P  KIM, D. B.  Catalyst development for coal liquefac	0603 A80-46724	water pollution control facility, [DOE/ET-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MWe combined cycle MHD/system electrical power	Volume 1 p0749 N80-31922 ned closed
Interface recombination and junction f in the Cu25-Cd5 solar cell  P KIM, D. R. Catalyst development for coal liquefac [BPRI-AF-1233]  P	0603 A80-46724	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MMe combi cycle MHD/system electrical power plants	volume 1 p0749 N80-31922 ned closed generating
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. R.  Catalyst development for coal liquefac [EPRI-AF-1233]  PRIBLE, F. H.	0603 A80-46724 tion 0696 N80-29508	water pollution control facility, [DOE/ET-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MMe combi cycle MHD/system electrical power plants [TH-78-E-91]	Volume 1 p0749 N80-31922 ned closed
Interface recombination and junction f in the Cu25-CdS solar cell  KIM, D. R.  Catalyst development for coal liquefac [EPRI-AF-1233] p  KHBDL, P. H.  Worldwide survey of current experience	0603 A80-46724 tion 0696 N80-29508 burning	water pollution control facility, [DDE/ET-12431/T1-VOL-1]  KLEYN, D.  A parametric study of 1000 MWe combicycle HHD/system electrical power plants [TH-78-E-91]  KLIER, K.	volume 1 p0749 N80-31922 ned closed generating
Interface recombination and junction f in the Cu2S-CdS solar cell  KIB, D. K. Catalyst development for coal liquefac [FFRI-AF-1233] p KIBDL, P. B. Worldwide survey of current experience residual and crude oils in gas turbi	0603 A80-46724 tion 0696 N80-29508 burning nes	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIBE, K.  Bethanol and methyl fuel catalyst	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931
Interface recombination and junction f in the Cu2S-CdS solar cell  P  KIM, D. E.  Catalyst development for coal liquefac [FFRI-AF-1233]  FINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [FFRI-AF-1243]  P	0603 A80-46724 tion 0696 N80-29508 burning	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MWe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIER, K.  Methanol and methyl fuel catalyst [FE-3177-5]	volume 1 p0749 N80-31922 ned closed generating
Interface recombination and junction f in the Cu2S-CdS solar cell  RIM, D. E.  Catalyst development for coal liquefac [BPRI-AF-1233] p  KINDL, F. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BPRI-AF-1243] p  KING, G. H.	0603 A80-46724 tion 0696 N80-29508 burning nes 0693 N80-28724	water pollution control facility, [DDE/ET-12431/T1-VOL-1]  KLEYB, D.  A parametric study of 1000 MWe combicycle MHD/system electrical power plants [TH-78-E-91]  KLIBB, K.  Methanol and methyl fuel catalyst [PE-3177-5]  KLIELING, G. R.	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472
Interface recombination and junction f in the Cu2S-CdS solar cell  P  KIM, D. E.  Catalyst development for coal liquefac [FFRI-AF-1233]  FINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [FFRI-AF-1243]  P	0603 A80-46724 tion 0696 N80-29508 burning nes 0693 N80-28724	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MWe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIEE, K.  Methanol and methyl fuel catalyst [PE-3177-5]  KLIMZING, G. E.  Hydrogen distribution and transfer i hydrogenation systems	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [EPRI-AF-1233] P  KINDL, F. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EPRI-AF-1243] P  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels	0603 A80-46724 tion 0696 N80-29508 burning nes 0693 N80-28724	water pollution control facility, [DDE/ET-12431/T1-VOL-1]  KLEYS, D.  A parametric study of 1000 MPe combicycle MHD/system electrical power plants [TH-78-E-91]  KLIER, K.  Methanol and methyl fuel catalyst [FE-3177-5]  KLIBELSG, G. E.  Hydrogen distribution and transfer in hydrogenation systems [DDE/PC-30014/1]	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. R.  Catalyst development for coal liquefac [SPRI-AF-1233] p  KIMDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [SPRI-AF-1243] p  KIMG, G. H.  UK Department of Energy Solar Biologic - Biofuels  KIMG, J. H.	0603 A80-46724 tion 0696 N80-29508 burning nes 0693 N80-28724 al Programme	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MMe combi cycle MED/system electrical power plants [TH-78-E-91]  KLIER, K.  Methanol and methyl fuel catalyst [PE-3177-5]  KLIEKING, G. R.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTIL. R. C.	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473
Interface recombination and junction f in the Cu2S-CdS solar cell  P  KIM, D. E.  Catalyst development for coal liquefac [BPRI-AP-1233]  FINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BPRI-AP-1243]  FING, G. H.  UK Department of Energy Solar Biologic - Biofuels  FING, J. H.  Advanced technology fuel cell program	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853	water pollution control facility, [DDE/ET-12431/T1-VOL-1]  KLEYS, D.  A parametric study of 1000 MPe combicycle MHD/system electrical power plants [TH-78-E-91]  KLIER, K.  Methanol and methyl fuel catalyst [FE-3177-5]  KLIBELSG, G. E.  Hydrogen distribution and transfer in hydrogenation systems [DDE/PC-30014/1]	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [EPRI-AP-1233]  FINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EPRI-AP-1243]  FING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [EPRI-EB-1328]	0603 A80-46724 tion 0696 N80-29508 burning nes 0693 N80-28724 al Programme	water pollution control facility, [DOE/ET-12431/T1-VOL-1]  KLEYB, D.  A parametric study of 1000 MMe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIER, K.  Methanol and methyl fuel catalyst [FE-3177-5]  KLIMEING, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C. Development of space-qualified Gals	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [EFRI-AF-1233] p  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EFRI-AF-1243] p  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [EPRI-EM-1328] p  KINOSHITA, K.	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIBE, K.  Methanol and methyl fuel catalyst [PE-3177-5]  KLIBEIEG, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C. Development of space-qualified Gals  KHIGHT, J. F.	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal p0758 N80-29473 solar cells p0658 N80-33888
Interface recombination and junction f in the Cu2S-CdS solar cell  P  KIH, D. E.  Catalyst development for coal liquefac [BFRI-AF-1233]  FINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BPRI-AF-1243]  FING, G. H.  UK Department of Energy Solar Biologic - Biofuels  FING, J. H.  Advanced technology fuel cell program [BFRI-BH-1328]  FINOSHITA, K.  Testing of sintered LiAlO2 structures	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 M9e combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIER, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIEZIBC, G. R.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHIL, R. C. Development of space-qualified Gals  KNIGHT, J. P. Simulation of mass transfer processe	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in
Interface recombination and junction f in the Cu2S-CdS solar cell  RIM, D. R.  Catalyst development for coal liquefac [EPBI-AP-1233]  FINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EPRI-AP-1243]  FING, G. H.  UK Department of Energy Solar Biologic - Biofuels  FING, J. H.  Advanced technology fuel cell program [EPRI-BM-1328]  KINGSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells	0603 A80-46724  tion 0696 N80-29508  burning nes 06693 N80-28724  al Programme 0687 A80-52853  0752 N80-32677  in molten	water pollution control facility, [DOE/ET-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combicycle MHD/system electrical power plants [TH-78-E-91]  KLIER, K.  Methanol and methyl fuel catalyst [FE-3177-5]  KLINZING, G. E.  Hydrogen distribution and transfer in hydrogenation systems [DOE/PC-30014/1]  KHECHTLI, R. C.  Development of space-qualified Gals  KHIGHT, J. F.  Simulation of mass transfer processe geothermal power cycles with direction in the company of the compa	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [EFRI-AP-1233] p  KIHDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EFRI-AP-1243] p  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [EPRI-EM-1328]  KINOSHITA, K.  Testing of sintered LiAlO2 structures carronate fuel cells	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 M9e combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIER, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIEZIBC, G. R.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHIL, R. C. Development of space-qualified Gals  KNIGHT, J. P. Simulation of mass transfer processe	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal p0758 N80-29473 solar cells p0658 N80-33888 s in t contact heat
Interface recombination and junction f in the Cu2S-CdS solar cell  P  KIH, D. E.  Catalyst development for coal liquefac [BFRI-AF-1233]  FINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BPRI-AF-1243]  FING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [BPRI-BH-1328]  FINOSHITA, K.  Testing of sintered LiAlO2 structures carkonate fuel cells  P  KIRCHGAESSNEE, B.	0603 A80-46724  tion 0696 N80-29508  burning 0693 N80-28724  al Programme 0687 A80-52853  00752 N80-32677  in molten	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MMe combi cycle MED/system electrical power plants [TH-78-E-91]  KLIER, E.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIMEING, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHIL, B. C.  Development of space-qualified Gals  KNIGHT, J. P. Simulation of mass transfer processe geothermal power cycles with direc exchange	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in
Interface recombination and junction f in the Cu2S-CdS solar cell  RIM, D. R.  Catalyst development for coal liquefac [FPRI-AF-1233] p  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [FPRI-AF-1243] p  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [FPRI-BH-1328] p  KINGSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGAESSHEE, B.  Static investigation of rotor blades a	0603 A80-46724  tion 0696 N80-29508  burning 0693 N80-28724  al Programme 0687 A80-52853  00752 N80-32677  in molten	water pollution control facility, [DOE/ET-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combicycle MHD/system electrical power plants [TH-78-E-91]  KLIEE, K.  Methanol and methyl fuel catalyst [PE-3177-5]  KLINEING, G. E.  Hydrogen distribution and transfer in hydrogenation systems [DOE/PC-30014/1]  KHECHTLI, B. C.  Development of space-qualified Gams  KHIGHT, J. F.  Simulation of mass transfer processe geothermal power cycles with direct exchange  KHIGHTLI, W. F.	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in t contact heat p0724 &80-48222
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [EFRI-AP-1233] p  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EFRI-AP-1243] p  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [EFRI-EM-1328] p  KINOSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGARSSNEE, B.  Static investigation of rotor blades a under quasi-stationary loading	0603 A80-46724  tion 0696 N80-29508  burning 0693 N80-28724  al Programme 0687 A80-52853  00752 N80-32677  in molten	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIBE, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIBEIEG, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C. Development of space-qualified Gaas  KHIGHT, J. F. Simulation of mass transfer processe geothermal power cycles with direc exchange  KHIGHTLY, W. F. Cogeneration Technology Alternatives	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in t contact heat p0724 &80-48222
Interface recombination and junction f in the Cu2S-CdS solar cell  PRIMA, D. B. Catalyst development for coal liquefac [BPBI-AF-1233]  WINDL, P. H. Worldwide survey of current experience residual and crude oils in gas turbi [BPRI-AF-1243]  WING, G. H. UK Department of Energy Solar Biologic - Biofuels  WING, J. H. Advanced technology fuel cell program [BPBI-BH-1328]  WINOSHITA, K. Testing of sintered LiAlO2 structures carbonate fuel cells  WIRCHGARSSHER, B. Static investigation of rotor blades a under quasi-stationary loading [ISD-243] Stability and dynamic response to grav	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  0752 N80-32677  in molten 0721 A80-47143  t rest and 0747 N80-30948 itational	water pollution control facility, [DOE/ET-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 M9e combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIER, K.  Methanol and methyl fuel catalyst [FE-3177-5]  KLINZING, G. R.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, B. C.  Development of space-qualified Gals  KHIGHT, J. F.  Simulation of mass transfer processe geothermal power cycles with direc exchange  KHIGHTLY, W. F.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766]	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in t contact heat p0724 &80-48222 Study (CTAS). p0741 %80-28859
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [SPRI-AP-1233] p  KHDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BPRI-AP-1243] p  KIMG, G. H.  UK Department of Energy Solar Biologic - Biofuels  KIMG, J. H.  Advanced technology fuel cell program [EPRI-BH-1328] p  KINOSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGARSSHER, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243]  Stability and dynamic response to grav forces of the flapping and lead-lag	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  0752 N80-32677  in molten 0721 A80-47143  t rest and 0747 N80-30948 itational hinges on a	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIBE, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIBEIEG, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C. Development of space-qualified Gals  KHIGHT, J. F. Simulation of mass transfer processe geothermal power cycles with direc exchange  KHIGHTLY, E. F. Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766] Cogeneration Technology Alternatives	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal p0758 N80-29473 solar cells p0658 N80-33888 s in t contact heat p0724 N80-48222 Study (CTAS). p0741 N80-28859 Study (CTAS).
Interface recombination and junction f in the Cu2S-CdS solar cell  PRIM, D. R.  Catalyst development for coal liquefac [BFRI-AF-1233]  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BPRI-AF-1243]  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [BPRI-BH-1328]  KINOSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGARSSHEB, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243]  Stability and dynamic response to grav forces of the flapping and lead-lag rigid rotor blade with the leading-e	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  0752 N80-32677  in molten 0721 A80-47143  t rest and 0747 N80-30948 itational hinges on a	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MMe combi cycle MED/system electrical power plants [TH-78-E-91]  KLIER, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIEZING, G. R.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHIL, R. C. Development of space-qualified Gals  KNIGHT, J. P. Simulation of mass transfer processe geothermal power cycles with direc exchange  KNIGHTLY, W. P. Cogeneration Technology Alternatives Yolume 2: Analytical approach [NASA-CR-159766] Cogeneration Technology Alternatives Yolume 6: Computer data. Part 1:	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in t contact heat p0724 &80-48222 Study (CTAS). p0741 %80-28859 Study (CTAS). Coal-fired
Interface recombination and junction f in the Cu2S-CdS solar cell  PRIM, D. E.  Catalyst development for coal liquefac [BPBI-AF-1233]  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BPRI-AF-1243]  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. M.  Advanced technology fuel cell program [BPBI-BH-1328]  KINOSHITA, K.  Testing of sintered LiAlO2 structures carlonate fuel cells  KIRCHGAESSHEE, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243]  Stability and dynamic response to grav forces of the flapping and lead-lag rigid rotor blade with the leading-e attack and flapping being coupled	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  0752 N80-32677  in molten 0721 A80-47143  t rest and 0747 N80-30948  itational hinges on a dige angle of	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 M9e combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIER, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIERING, G. R.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KMECHTLI, R. C.  Development of space-qualified Gals  KHIGHT, J. P.  Simulation of mass transfer processe geothermal power cycles with direc exchange  KHIGHTLY, W. P.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766]  Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration process boiler, sec	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in t contact heat p0724 &80-48222 Study (CTAS). p0741 %80-28859 Study (CTAS). Coal-fired
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [EFRI-AP-1233] p  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EPRI-AP-1243] p  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [EPRI-BH-1328] p  KINOSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGARESSNEE, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243]  Stability and dynamic response to grav forces of the flapping and lead-lag rigid rotor blade with the leading-e attack and flapping being coupled [ISD-244] p	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  0752 N80-32677  in molten 0721 A80-47143  at rest and 0747 N80-30948  itational hinges on a dge angle of	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIBE, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIBEIEG, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C.  Development of space-qualified Gams  KHIGHT, J. F.  Simulation of mass transfer processe geothermal power cycles with direc exchange  KHIGHTLY, E. F.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766]  Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration process boiler, sec [NASA-CR-159770-FT-1-A]	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal p0758 N80-29473 solar cells p0658 N80-33888 s in t contact heat p0724 N80-48222 Study (CTAS). p0741 N80-28859 Study (CTAS). Coal-fired tion A p0745 N80-30888
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. R.  Catalyst development for coal liquefac [SPRI-AP-1233]  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EPRI-AP-1243]  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [EPRI-EH-1328]  KINOSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGARSSHEB, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243]  Stability and dynamic response to graw forces of the flapping and lead-lag rigid rotor blade with the leading-e attack and flapping being coupled [ISD-244]  Dynamic analysis of a rotor blade with	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  0752 N80-32677  in molten 0721 A80-47143  at rest and 0747 N80-30948  itational hinges on a dge angle of	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MPe combi cycle MED/system electrical power plants [TH-78-E-91]  KLIER, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIEZING, G. R.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C. Development of space-qualified Gals  KNIGHT, J. P. Simulation of mass transfer processe geothermal power cycles with direc exchange  KNIGHTLY, W. P.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766] Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration process, boiler, sec [NASA-CR-159770-PT-1-A] Cogeneration Technology Alternatives	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in t contact heat p0724 &80-48222 Study (CTAS). p0741 (CTAS). Coal-fired tion A p0745 %80-30888 Study (CTAS).
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [BRRI-AF-1233] p  KINDL, F. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BRRI-AF-1243] p  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [BRRI-BH-1328]  KINOSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGARSSNER, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243] Stability and dynamic response to grav forces of the flapping and lead-lag rigid rotor blade with the leading- attack and flapping being coupled [ISD-244] Dynamic analysis of a rotor blade with freedom, flapping freedom, and	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  00752 N80-32677  in wolten 00721 A80-47143  t rest and 00747 N80-30948 itational hinges on a dige angle of 10747 N80-30949 lead-lag	water pollution control facility, [DOE/ET-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MWe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIBE, K.  Bethanol and methyl fuel catalyst [FE-3177-5]  KLIBEING, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KBECHTLI, B. C.  Development of space-qualified Gals  KHIGHT, J. P.  Simulation of mass transfer processe geothermal power cycles with direc exchange  KHIGHTLY, W. P.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CE-159766]  Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1:	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal p0758 N80-29473 solar cells p0658 N80-33888 s in t contact heat p0724 A80-48222 Study (CTAS). p0741 N80-28859 Study (CTAS). Coal-fired tion A p0745 N80-30888 Study (CTAS). Coal-fired
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [EFRI-AP-1233] p  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EPRI-AP-1243] p  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [EPRI-BH-1328] p  KINOSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KINCHGAESSHEE, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243] Stability and dynamic response to grav forces of the flapping and lead-lag rigid rotor blade with the leading-e attack and flapping being coupled [ISD-244] Dynamic analysis of a rotor blade with freedom, flapping freedom, and variable-controlled blade pitch angl	10603 A80-46724  tion 10696 N80-29508  burning 10693 N80-28724  al Programme 10687 A80-52853  10752 N80-32677  in molten 10721 A80-47143  at rest and 10747 N80-30948  itational 1 hinges on a 1 dge angle of 10747 N80-30949  lead-lag  e	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIBE, K.  Methanol and methyl fuel catalyst [PE-3177-5]  KLIBEIEG, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C.  Development of space-qualified Gams  KHIGHT, J. F.  Simulation of mass transfer processe geothermal power cycles with direc exchange  KHIGHTLY, W. F.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766]  Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal p0758 N80-29473 solar cells p0658 N80-33888 s in t contact heat p0724 A80-48222 Study (CTAS). p0741 N80-28859 Study (CTAS). Coal-fired tion A p0745 N80-30888 Study (CTAS). Coal-fired tion B
Interface recombination and junction f in the Cu2S-CdS solar cell  PRIM, D. R.  Catalyst development for coal liquefac [BFBI-AF-1233]  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BFBI-AF-1243]  KING, G. B.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [BFBI-BH-1328]  KINOSHTA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGAESSHEB, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243]  Stability and dynamic response to graw forces of the flapping and lead-lag rigid rotor blade with the leading-e attack and flapping being coupled [ISD-244]  Dynamic analysis of a rotor blade with freedom, flapping freedom, and variable-controlled blade pitch angl [ISD-258]	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  00752 N80-32677  in wolten 00721 A80-47143  t rest and 00747 N80-30948 itational hinges on a dige angle of 10747 N80-30949 lead-lag	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MPe combi cycle MED/system electrical power plants [TH-78-E-91]  KLIER, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIEZING, G. R.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C. Development of space-qualified Gals  KNIGHT, J. P. Simulation of mass transfer processe geothermal power cycles with direc exchange  KNIGHTLY, W. P.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766] Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Process boiler, sec [NASA-CR-159770-PT-1-8]	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal p0758 N80-29473 solar cells p0658 N80-33888 s in t contact heat p0724 A80-48222 Study (CTAS). p0741 N80-28859 Study (CTAS). Coal-fired tion A p0745 N80-30888 p0745 N80-30888
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [EFRI-AP-1233] p  KINDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EPRI-AP-1243] p  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [EPRI-BH-1328] p  KINOSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KINCHGAESSHEE, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243] Stability and dynamic response to grav forces of the flapping and lead-lag rigid rotor blade with the leading-e attack and flapping being coupled [ISD-244] Dynamic analysis of a rotor blade with freedom, flapping freedom, and variable-controlled blade pitch angl	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  00752 N80-32677  in wolten 00721 A80-47143  t rest and 00747 N80-30948  itational hinges on a dige angle of 00747 N80-30949 lead-lag e 00747 N80-30950	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIBE, K.  Methanol and methyl fuel catalyst [PE-3177-5]  KLIBEIEG, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C.  Development of space-qualified Gams  KHIGHT, J. F.  Simulation of mass transfer processe geothermal power cycles with direc exchange  KHIGHTLY, W. F.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766]  Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives	volume 1 p0749 %80-31922 ned closed generating p0742 %80-28931 p0708 %80-32472 n coal p0758 %80-29473 solar cells p0658 %80-33888 s in t contact heat p0724 &80-48222 Study (CTAS). p0741 %80-28859 Study (CTAS). Coal-fired tion A p0745 %80-30888 study (CTAS). Coal-fired tion B p0745 %80-30889
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. K.  Catalyst development for coal liquefac [EFRI-AF-1233] p  KINDL, F. H.  Worldwide survey of current experience residual and crude oils in gas turbi [EFRI-AF-1243] p  KING, G. H.  UK Department of Energy Solar Biologic - Biofuels  KING, J. H.  Advanced technology fuel cell program [EFRI-BH-1328] p  KINOSHITA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGAESSNER, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243] Stability and dynamic response to grav forces of the flapping and lead-lag rigid rotor blade with the leading- attack and flapping being coupled [ISD-244] Dynamic analysis of a rotor blade with freedom, flapping freedom, and variable-controlled blade pitch angl [ISD-258]  KISSHIMAM, K. I.	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  0752 N80-32677  in molten 0721 A80-47143  t rest and 0747 N80-30948  itational hinges on a dge angle of 0747 N80-30949 lead-lag e 0747 N80-30950 for an	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MPe combi cycle MED/system electrical power plants [TH-78-E-91]  KLIER, K.  Bethanol and methyl fuel catalyst [PE-3177-5]  KLIEZIBG, G. R.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C. Development of space-qualified Gals  KNIGHT, J. P. Simulation of mass transfer processe geothermal power cycles with direc exchange  KNIGHTLY, W. P.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766] Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration process boiler, sec [NASA-CR-159770-PT-1-A] Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration process boiler, sec [NASA-CR-159770-PT-1-B] Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration Technology Alternatives Volume 6: Computer data. Part 2: Residual-fired nocogeneration proc	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal p0758 N80-29473 solar cells p0658 N80-33888 s in t contact heat p0724 N80-48222 Study (CTAS). p0741 N80-28859 Study (CTAS). Coal-fired tion A p0745 N80-30888 Study (CTAS). Coal-fired tion B p0745 N80-30889 Study (CTAS).
Interface recombination and junction f in the Cu2S-CdS solar cell  KIM, D. R.  Catalyst development for coal liquefac [BFBI-AF-1233]  KIMDL, P. H.  Worldwide survey of current experience residual and crude oils in gas turbi [BFBI-AF-1243]  KIMG, G. B.  UK Department of Energy Solar Biologic - Biofuels  KIMG, J. H.  Advanced technology fuel cell program [BFBI-BH-1328]  KIMOSHTA, K.  Testing of sintered LiAlO2 structures carbonate fuel cells  KIRCHGAESSHEB, B.  Static investigation of rotor blades a under quasi-stationary loading [ISD-243]  Stability and dynamic response to graw forces of the flapping and lead-lag rigid rotor blade with the leading-e attack and flapping being coupled [ISD-244]  Dynamic analysis of a rotor blade with freedom, flapping freedom, and variable-controlled blade pitch angl [ISD-258]  KISHIYANA, K. I.  Use of an automated mass spectrometer underground coal gasification field	0603 A80-46724  tion 0696 N80-29508  burning nes 0693 N80-28724  al Programme 0687 A80-52853  0752 N80-32677  in molten 0721 A80-47143  t rest and 0747 N80-30948  itational hinges on a dge angle of 0747 N80-30949 lead-lag e 0747 N80-30950 for an	water pollution control facility, [DOE/BT-12431/T1-VOL-1]  KLEYE, D.  A parametric study of 1000 MHe combi cycle MHD/system electrical power plants [TH-78-E-91]  KLIBE, K.  Methanol and methyl fuel catalyst [PE-3177-5]  KLIBEIEG, G. E.  Hydrogen distribution and transfer i hydrogenation systems [DOE/PC-30014/1]  KNECHTLI, R. C.  Development of space-qualified GaAs  KHIGHT, J. F.  Simulation of mass transfer processe geothermal power cycles with direc exchange  KHIGHTLY, W. F.  Cogeneration Technology Alternatives Volume 2: Analytical approach [NASA-CR-159766]  Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration process boiler, sec [NASA-CR-159770-PT-1-A]  Cogeneration Technology Alternatives Volume 6: Computer data. Part 1: nocogeneration process boiler, sec [NASA-CR-159770-PT-1-B]  Cogeneration Technology Alternatives Volume 6: Computer data. Part 1:	volume 1 p0749 N80-31922 ned closed generating p0742 N80-28931 p0708 N80-32472 n coal p0758 N80-29473 solar cells p0658 N80-33888 s in t contact heat p0724 N80-48222 Study (CTAS). p0741 N80-28859 Study (CTAS). Coal-fired tion A p0745 N80-30888 Study (CTAS). Coal-fired tion B p0745 N80-30889 Study (CTAS).

Cogeneration Technology Alternatives Study (CTAS).

Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler, section A [MASA-CR-159770-PT-1] p0591 M80-33860 Cogeneration Technology Alternatives Study (CTAS).

Volume 6: Computer data. Part 2: Residual-fired nocogeneration process boiler [NASA-CR-159770-PT-2] p0591 N80 p0591 N80-33861 KROTT, G. P. Describing-function method for estimating the performance of a dynamic system having nonlinear-power take-off, with application to wave-power conversion D0739 A80-51464 KHOWLES, G. R. Bigh-efficiency concentration/multi-solar-cell system for orbital power generation p0614 A80-48207 KOCHIAN, L. V.
Solar energy conversion through biophotolysis
[SAB-0034-239-1-T2] p0666 N8 p0666 N80-31927 KOCHEA, B. L.
KED electrode development [PB-15529-5] p0748 N80-31222 KORBLER, C. R. Nickel-hydrogen batteries for INTELSAT V p0770 A80-48438 Autonomous solar-electric systems n0596 A80-45477 KOHLMANNSPERGER, J.
Solar cells with concentrating collectors and integrated heat use system n0604 A80-46742 KOKHOVA. I. I. Estimating capacity of solar thermoelectric generator /STEG/ panels p0610 A80-47155 KOKOSZENSKI, J. Energy conversion considerations of the STARFIRE commercial fusion power plant p0733 A80-48490 KOLB. C. R. Characterization of open-cycle, coal-fired MHD generators (ARI-BP-431 p0750 N80-31936 Characterization of open-cycle, coal-fired MHD generators Ĩ ARI-RP-461 p0751 N80-32234 KOLIPAD, K. H.
Some characteristics of low-cost silicon sheet D0605 A80-46756 Investigation of the characteristics of electrochemical coatings for solar-radiation collectors p0611 A80-47164 KOLUCE, B. J. Industrial application and assessment of waste energy recovery technologies p0745 N80-30886 Pollution control improvements in coal-fired electric generating plants - What they accomplish, what they cost p0573 A80-49648 KONDBATENKO, A. D. A study of the heat-induced fracture characteristics of materials under intense radiant heating p0609 A80-46815 KONG. M. K. Comparative analysis of aluminum-air battery propulsion systems for passenger vehicles D0778 N80-32907 [UCRL-52933] KONHEIN, C. S.
Start-up consideration in utility use of a refuse derived fuel p0673 A80-48276 KONOPLEY, V. IO.

End zone of a frame-type channel with an inhomogeneous flow p0739 A80-52555 KONDIARZ, H. Services rendered for waste incineration power plants technology and implementation exemplified with the waste incineration heating power plant of the seaport of Bremerhaven p0682 A80-49966

KOOMAHOPP, P. A. Status of the satellite power system concept development and evaluation program p0623 A80-50952 KOPSTRIB, B. J.
Status of peat biogasification development D0674 A80-48293 KORDESCH, K. V.
Improved alkaline hydrogen/air fuel cells for transportation applications p0726 A80-48282 Puel cell applied research: Electrocatalysis and materials [BNL-51053] p0742 N80-28920 KORIAVKO, V. I. Form factor for certain types of toroidal solenoids p0721 A80-47230 KORNPELD, J. [AD-A086506] program p0701 N80-30904 KOROSI, A. Hydroprocessing of light pyrolysis fuel oil for kerosene type jet fuel p0713 N80-33599 KORSUN, V. Optimization studies of materials in hydrogenated amorphous silicon solar cells D0602 A80-46717 Global model of countercurrent coal gasifiers n0686 A80-51571 KOTTRIO, G. K.
Metallic thermoelectric materials in solar thermoelectric generators p0610 A80-47152 KOWALIK, J. Thermoelectric OTEC - An update n0731 A80-48436 ROWALIK, J. S.
Solar ponds for district heating and electricity generation D0618 480-48367 KOWALSKI, J. M. Hodels for the photoelectrolytic decomposition of water at semiconducting oxide anodes p0664 A80-50512 Magnetoplasma compressor with an explosion-driven magnetic power generator . p0717 480-44185 KPOSICK, D. 1.
Solubility of selected major and minor elements from coal and fly ash accumulations [ PB80-175334 ] p0580 N80-29926 KRAFT, C. C., JR.

The solar power satellite concept - The past decade and the next decade D0623 A80-50951 KRAKOUSKI, R. A. Present and future status of thermochemical cycles applied to fusion energy sources p0663 A80-48450 The reversed-field pinch fusion reactor P0733 A80-48492 KRAMBBEGER, P. E. Assessment of Synthane mechanical equipment p0710 N80-32572 [ MTI-79TR5 ] KRANICH, W. L. Kinetics and mechanisms of catalytic hydroliquefaction and hydrogasification of liquite p0691 N80-28555 [FE-2702-8] Kinetics and mechanisms of catalytic hydroliquefaction and hydrogasification of lignite [FE-2702-10] p0709 880-32556 erante, u. b. A water-influx model for UCG with spalling-enhanced drying p0676 A80-48343 ERASE, W. B. A quantitative evaluation of closed-cycle ocean thermal energy conversion (OTEC) technology in central station applications [R-2595-DOE] p0749 N80-3 p0749 N80-31885 KRAUTHANDE, S. Blectrochemical energy storage systems for solar thermal applications [NASA-CR-163432] p0636 N80-29858

KRAWIEC, P. Investigation of learning and experience	e curves	WEINOTO, J.  Visible light response of polycrysta.	lline TiO2
[SBRI/TR-353-459] p06	646 B80-31911	electrodes	p0664 A80-51691
Experimental studies of some regularitie underground gasification of inclined of		REZWEG, U. H. Maximum solar flux concentration ach axicon collectors	ievable with
KREITH, P.			p0625 A80-51679
A review of collector and energy storage technology for intermediate temperature applications		ISB, B. A.  Photovoltaic/thermal hybrid projects [BNL-27669]	p0638 H80-29881
End-use matching of solar energy system	595 A80-45311 s 624 A80-51208	Hybrid photovoltaic/thermal systems solar-assisted heat pump [BNL-27667]	with a p0642 N80-30919
KRIKGEIAE, C. E.	024 A00-31200	Solar assisted heat pump studies: He	
Materials considerations for the coupling thermochemical hydrogen cycles to tandreactors		hardware and experiments, simulaticoupling contracts and supporting [BNL-27668]	
p0	662 A80-48405 RU	SSMARB, A.	-
REISHEA. C.  Soot reduction in diesel engines by cate effects	alytic	Composite rotor blades for large win installations [NASA-TM-75822]	q energy - p0749 N80-31881
[BNL-27792] po:	585 B80-32731 KU	SEIK, J. A.	•
RRISHBAN, R. P. Assessment of current research and devel	lopment in	MED electrode development [FE-15529-5]	p0748 N80-31222
support of the U.S. coal liquefaction		ART, H.	•
demonstration plants program	577 A80-48428	Development of unique catalysts for hydrodenitrogenation of coal-derive	ed lianids
ERISHNAW, V. V.	777 800 40420	[PE-3297-1]	p0690 #80-28482
Material-flow data structures as a basis energy information system design	s for	Development of unique catalysts for hydrodenitrogenation of coal-derive	ad lianida
[LBL-10248] p0	760 N80-31923	[FE-3297-2]	p0690 N80-28545
KRISHASUANY, S. V.		Development of unique catalysts for	
Controlled cadmium telluride thin films cell applications (emerging materials		hydrodenitrogenation of coal-derive [FE-3297-3]	ed 11gulds p0690 N80-28546
for solar cell applications)	. KY	DES, A. S.	-
[DOB/ET-23023/T3] p06 KROEGER, P. A.	642 N80-30921	Comparative assessment of five long- projections	run energy
Low cost solar cells based on amorphous electrodeposited from organic solvent:		[ COE/EIA/CR-0016/02]	p0582 N80-30936
	648 N80-31953	L	
Low cost solar cells based on amorphous	silicon La	DERE, W. R.	
electrodeposited from organic solvent: [SAB-0113-040-T7] p0	5 637 N80-29873	The hydropyrolysis of coal to BTM	p0688 A80-53174
			•
KROLL, W.	. LA	PRESS, C.	Inhricating oil
Waste oil as a fuel	LA 684 A80-50032	PRENS, C. Why new technology to rerefine waste	lubricating oil p0685 A80-50033
Waste oil as a fuel po	684 A80-50032	Why new technology to rerefine waste ITY, W. W.	p0685 · A80-50033
Waste oil as a fuel po	684 A80-50032	Why new technology to rerefine waste	p0685 · A80-50033
Waste oil as a fuel  EMUPEA, H. C.  Assessment of environmental control technology storage systems, 1979  [LA-8308-HS]  political politi	684 A80-50032 LA bnologies 588 B80-32973	Why new technology to rerefine waste  ITY, W. W.  Assessment of solar thermal concepts power systems applications	p0685 · A80-50033
Waste oil as a fuel  REUPKA, B. C.  Assessment of environmental control technic for energy storage systems, 1979  [LA-8308-HS] possible C.  Analysis, design and realization of a 5	684 A80-50032 La hnologies 588 H80-32973	Why new technology to rerefine waste III. W. W. Assessment of solar thermal concepts	p0685 A80-50033 for small p0618 A80-48463
Waste oil as a fuel  RRUPKA, H. C.  Assessment of environmental control technology storage systems, 1979 [LA-8308-HS]  RRUSE, C.  Analysis, design and realization of a 5 photovoltaic generator	684 A80-50032 hnologies 588 H80-32973 km 605 A80-46745	Why new technology to rerefine waste  III, W. W.  Assessment of solar thermal concepts power systems applications  II, I. W.  Surface passivation of inversion lay solar cells	p0685 A80-50033 for small p0618 A80-48463
Waste oil as a fuel  ERUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-HS]  ERUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  (KUDESHOVA, L. P. Solar cells for terrestrial applications	684 A80-50032 hnologies 588 B80-32973 kB 605 A80-46745	Why new technology to rerefine waste  ITY, W. W.  Assessment of solar thermal concepts power systems applications  M, Y. W.  Surface passivation of inversion lay	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy
Waste oil as a fuel  RRUPKA, B. C.  Assessment of environmental control technology storage systems, 1979  [LA-8308-MS] p0:  RRUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  (RUDESHOVA, L. P.  Solar cells for terrestrial applications p0:  RURBERR, J.	684 A80-50032 bnologies 588 B80-32973 kW 605 A80-46745 LA 511 A80-47156	Why new technology to rerefine waste  ITY, W. W.  Assessment of solar thermal concepts power systems applications  IN, I. W.  Surface passivation of inversion lay- solar cells  IMB, J. P.  Generalized performance predictions	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal
Waste oil as a fuel  REUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-HS]  REUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  (KUDESHOVA, L. P. Solar cells for terrestrial applications  EURHBER, J.  An analysis of criteria for evaluating processing statements.	684 A80-50032 Labologies 588 B80-32973 La 605 A80-46745 511 A80-47156 proposals	Why new technology to rerefine waste  IIY, W. W.  Assessment of solar thermal concepts power systems applications.  II, I. W.  Surface passivation of inversion lay- solar cells.  IBB, J. P. Generalized performance predictions conversion plants using geopressur-	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy
Waste oil as a fuel  REUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-HS] p0:  REUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  EUDESHOVA, L. P.  Solar cells for terrestrial application:  EURBBER, J.  An analysis of criteria for evaluating for recovery of material and energy fi	684 A80-50032 Labologies 588 B80-32973 La 605 A80-46745 La 511 A80-47156 proposals com refuse 574 A80-49931	Why new technology to rerefine waste  III, W. W.  Assessment of solar thermal concepts power systems applications  M. I. W.  Surface passivation of inversion lay solar cells  MB, J. P.  Generalized performance predictions conversion plants using geopressur fluids  MPBRI, C. M.  Metallurgical analysis and high temp degradation of the black chrome se	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268 erature lective absorber
Waste oil as a fuel  REUPKA, B. C.  Assessment of environmental control tech for energy storage systems, 1979 [LA-8308-BS] p0:  REUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  (CUDESHOVA, L. P. Solar cells for terrestrial applications (CUBBER, J.  An analysis of criteria for evaluating in for recovery of material and energy fi  EURHSTLER, B. Bergy savings in a rotary kiln in the in of cement through the addition of dome	684 A80-50032 Labologies 588 B80-32973 Lab 605 A80-46745 Lab 511 A80-47156 proposals com refuse 574 A80-49931 production	Why new technology to rerefine waste  III, W. W.  Assessment of solar thermal concepts power systems applications  M. I. W.  Surface passivation of inversion lay solar cells  MB, J. P.  Generalized performance predictions conversion plants using geopressur fluids  MPBRT, C. M.  Hetallurgical analysis and high temp	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268
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Waste oil as a fuel  REUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-HS]  REUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  KUDESHOVA, L. P.  Solar cells for terrestrial applications  FUERBER, J.  An analysis of criteria for evaluating for recovery of material and energy fi  EURESTLEE, H.  Energy savings in a rotary kiln in the post cement through the addition of dome and sewage sludge  KURL, A. L.  Perspectives on research on LHG vapor consistency.  EULESA, F.	684 A80-50032 Labologies 588 B80-32973 LB 605 A80-46745 LA 5511 A80-47156 proposals com refuse 574 A80-49931 production estic Waste LA 590 B80-33593	Why new technology to rerefine waste  ITY, W. W.  Assessment of solar thermal concepts power systems applications  IM, I. W.  Surface passivation of inversion lay- solar cells  IMB, J. P.  Generalized performance predictions conversion plants using geopressur- fluids  IMPERT, C. M.  Metallurgical analysis and high temp- degradation of the black chrome se- [LBL-10293]  IMPKIN, C. M.  An S.E.M. study of thin films made b- pyrolysis  IMPALL, M. T.  Homentum theory analysis of unconven- ertraction schemes, part 10 [ASRL-TR-194-2-PT-10]	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268 erature lective absorber p0643 N80-31538 y spray p0603 A80-46729
Waste oil as a fuel  REUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-MS]  REUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  RUDESHOVA, L. P.  Solar cells for terrestrial application por solar cells for terrestrial application for recovery of material and energy for recovery of material and energy for polymers.  RURHSTLER, H.  Bnergy savings in a rotary kiln in the pof cement through the addition of domaind sewage sludge  RURL, A. L.  Perspectives on research on LNG vapor cidispersion  RULESA, F.  Improved alkaline hydrogen/air fuel cell	684 A80-50032 Labologies 588 B80-32973 LB 605 A80-46745 LA 5511 A80-47156 proposals com refuse 574 A80-49931 production estic Waste LA 590 B80-33593	Why new technology to rerefine waste  IIY, W. W.  Assessment of solar thermal concepts power systems applications.  M. Y. W.  Surface passivation of inversion lay- solar cells.  MB, J. P. Generalized performance predictions conversion plants using geopressur- fluids  MPBRT, C. M.  Metallurgical analysis and high temp- degradation of the black chrome se- [LBL-10293]  MPRIJ, C. M.  An S.E.M. study of thin films made h pyrolysis  MDAHL, M. T.  Homentum theory analysis of unconven- ertraction schemes, part 10 [ASBL-TR-194-2-PT-10]  MDRR, J. J.	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268 erature lective absorber p0643 N80-31538 y spray p0603 A80-46729 tional wind p0742 N80-28932
Waste oil as a fuel  REUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-HS] p0:  ERUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  KUDESHOVA, L. P.  Solar cells for terrestrial applications p0:  KURHBER, J.  An analysis of criteria for evaluating for recovery of material and energy find for recovery of material and energy find the search of cement through the addition of dome and sewage sludge  KURL, A. L.  Perspectives on research on LNG vapor continuous dispersion  KULESA, F.  Improved alkaline hydrogen/air fuel cell transportation applications	684 A80-50032 Labologies 588 B80-32973 LB 605 A80-46745 LA 5511 A80-47156 proposals com refuse 574 A80-49931 production estic Waste LA 590 B80-33593	Why new technology to rerefine waste  ITY, W. W.  Assessment of solar thermal concepts power systems applications  IM, I. W.  Surface passivation of inversion lay- solar cells  IMB, J. P.  Generalized performance predictions conversion plants using geopressur- fluids  IMPERT, C. M.  Metallurgical analysis and high temp- degradation of the black chrome se- [LBL-10293]  IMPKIN, C. M.  An S.E.M. study of thin films made b- pyrolysis  IMPALL, M. T.  Homentum theory analysis of unconven- ertraction schemes, part 10 [ASRL-TR-194-2-PT-10]	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268 erature lective absorber p0643 N80-31538 y spray p0603 A80-46729 tional wind p0742 N80-28932
Waste oil as a fuel  REUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-HS]  REUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  RUDESHOVA, L. P.  Solar cells for terrestrial application por recovery of material and energy for recovery of material and energy for cement through the addition of dome and sewage sludge  RUBLSA. P.  Improved alkaline hydrogen/air fuel cell transportation applications  RUHA, H. E. Advanced technology fuel cell program	684 A80-50032 Landologies 588 B80-32973 LA 605 A80-46745 LA 605 A80-47156 Proposals COM refuse 574 A80-49931 Production Pestic Waste LA 590 B80-33593 Ls for LA 726 A80-48282	Why new technology to rerefine waste  IIY, W. W.  Assessment of solar thermal concepts power systems applications.  II, Y. W.  Surface passivation of inversion lay- solar cells.  IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268 erature lective absorber p0643 N80-31538 y spray p0603 A80-46729 tional wind p0742 N80-28932 admium p0772 A80-48484
Waste oil as a fuel  REUPKA, M. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-MS]  REUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  KUDESHOVA, L. P.  Solar cells for terrestrial application:  EURHBER, J.  An analysis of criteria for evaluating for recovery of material and energy for recovery of material and energy for cament through the addition of dominand sewage sludge  EURL, A. L.  Perspectives on research on LNG vapor conservatives on research on LNG vapor conservation applications  EULESA, F.  Improved alkaline hydrogen/air fuel cell transportation applications  EUHA, B. B.  Advanced technology fuel cell program [EPEI-EM-1328]  EUNO, B.	684 A80-50032 Labologies 588 B80-32973 LB 605 A80-46745 S 511 A80-47156 Proposals Com refuse 574 A80-49931 Production estic waste LA 574 A80-49958 Loud LA 590 B80-33593 Ls for LA 726 A80-48282 LS 752 B80-32677	Why new technology to rerefine waste  IIY, W. W.  Assessment of solar thermal concepts power systems applications.  M. Y. W.  Surface passivation of inversion lay- solar cells.  MB, J. P.  Generalized performance predictions conversion plants using geopressur- fluids  MPBRT, C. M.  Hetallurgical analysis and high temp- degradation of the black chrome se [LBL-10293]  MPRIN, C. M.  An S.E.M. study of thin films made h pyrolysis  MDAHL, M. T.  Momentum theory analysis of unconven- ertraction schemes, part 10 [ASBL-TR-194-2-PT-10]  MDER, J. J.  New separator materials for nickel-co- aircraft batteries  MDGREBE, A. R.  Status of electrochemical energy sto- for electric vehicle, solar, and e-	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268 erature lective absorber p0643 N80-31538 y spray p0603 A80-46729 tional wind p0742 N80-28932 admium p0772 A80-48484 rage systems
Waste oil as a fuel  REUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-MS]  REUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  KUDESHOVA, L. P.  Solar cells for terrestrial applications  FOR the BER, J.  An analysis of criteria for evaluating for recovery of material and energy find the series of cament through the addition of domain sewage sludge  KURL, A. L.  Perspectives on research on LNG vapor consistency of transportation applications  KULESA, F.  Improved alkaline hydrogen/air fuel cell transportation applications  KUHA, H. B.  Advanced technology fuel cell program  [EPRI-EB-1328]  KUNO, H.  Development of a methane fermentation programic wastes	684 A80-50032 Labologies 588 B80-32973 La 605 A80-46745 La 605 A80-47156 proposals com refuse 574 A80-49931 production estic Waste La 590 B80-33593 Ls for 726 A80-48282 752 M80-32677 cocess for	Why new technology to rerefine waste  IIY, W. W.  Assessment of solar thermal concepts power systems applications  M. Y. W.  Surface passivation of inversion lay- solar cells  MB, J. P.  Generalized performance predictions conversion plants using geopressur- fluids  MPRET, C. M.  Metallurgical analysis and high temp- degradation of the black chrome se- [LBL-10293]  MPRIJ, C. M. An S.P.M. study of thin films made h- pyrolysis  MDAHL, M. T.  Momentum theory analysis of unconven- extraction schemes, part 10 [ASRL-TR-194-2-PT-10]  MDREB, J. J.  New separator materials for nickel- aircraft batteries  MDGREBE, A. R.  Status of electrochemical energy sto- for electric vehicle, solar, and e- utility applications	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268 erature lective absorber p0643 N80-31538 y spray p0603 A80-46729 tional wind p0742 N80-28932 admium p0772 A80-48484 rage systems
Waste oil as a fuel  REUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-HS] p0:  ERUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  KUDESHOVA, L. P.  Solar cells for terrestrial applications for recovery of material and energy fi  EURESTLER, H.  Energy savings in a rotary kiln in the point cement through the addition of dome and sewage sludge  KURL, A. L.  Perspectives on research on LHG vapor cidispersion  EULESA, F.  Improved alkaline hydrogen/air fuel cell transportation applications  EULESA, F.  Advanced technology fuel cell program [EPEI-EB-1328]  EUNO, H.  Development of a methane fermentation programic wastes	684 A80-50032 Labologies 588 B80-32973 La 605 A80-46745 La 605 A80-47156 proposals com refuse 574 A80-49931 production estic Waste La 590 B80-33593 Ls for 726 A80-48282 752 M80-32677 cocess for	Why new technology to rerefine waste  IIY, W. W.  Assessment of solar thermal concepts power systems applications  III, IV.  Surface passivation of inversion lay- solar cells  IIII, IV.  Generalized performance predictions conversion plants using geopressur- fluids  IMPERT, C. M.  Hetallurgical analysis and high temp- degradation of the black chrome se. [LBL-10293]  IMPRIN, C. M.  An S.E.M. study of thin films made h pyrolysis  IMDAHL, M. T.  Homentum theory analysis of unconven- ertraction schemes, part 10 [ASBL-TR-194-2-PT-10]  IMDER, J. J.  New separator materials for nickel-co- aircraft batteries  IMDGREBE, A. R.  Status of electrochemical energy stol for electric vehicle, solar, and electric utility applications  IMDRUM, J. H.  The aluminum-air battery for electric	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268 elective absorber p0643 N80-31538 y spray p0603 A80-46729 tional wind p0742 N80-28932 admium p0772 A80-48484 rage systems lectric
Waste oil as a fuel  REUPKA, H. C.  Assessment of environmental control tect for energy storage systems, 1979 [LA-8308-HS] p0:  ERUSE, C.  Analysis, design and realization of a 5 photovoltaic generator  KUDESHOVA, L. P.  Solar cells for terrestrial applications p0:  KURHBER, J.  An analysis of criteria for evaluating for recovery of material and energy find for recovery of material and energy find sevage sludge  KURHSTLER, H.  Energy savings in a rotary kiln in the post cement through the addition of dome and sevage sludge  KURL, A. L.  Perspectives on research on LNG vapor consistency p0:  KURLSA, F.  Improved alkaline hydrogen/air fuel cell transportation applications  KUHA, H. B.  Advanced technology fuel cell program [EPEI-EB-1328] p0:  KUNO, B.  Development of a methane fermentation programic wastes	684 A80-50032 Labologies 588 B80-32973 La 605 A80-46745 La 605 A80-47156 proposals com refuse 574 A80-49931 production estic Waste La 590 B80-33593 Ls for 726 A80-48282 752 M80-32677 cocess for	Why new technology to rerefine waste  IIY, W. W.  Assessment of solar thermal concepts power systems applications.  M. Y. W.  Surface passivation of inversion lay- solar cells.  MB, J. P.  Generalized performance predictions conversion plants using geopressur- fluids  MPBRT, C. M.  Hetallurgical analysis and high temp- degradation of the black chrome se [LBL-10293]  MPRIN, C. M.  An S.E.M. study of thin films made h pyrolysis  MDAHL, M. T.  Momentum theory analysis of unconven- ertraction schemes, part 10 [ASBL-TR-194-2-PT-10]  MDER, J. J.  New separator materials for nickel-co- aircraft batteries  MDGREBE, A. R.  Status of electrochemical energy sto- for electric vehicle, solar, and e- utility applications	p0685 A80-50033 for small p0618 A80-48463 er m.i.s. p0612 A80-48150 for energy ed geothermal p0725 A80-48268 elective absorber p0643 N80-31538 y spray p0603 A80-46729 tional wind p0742 N80-28932 admium p0772 A80-48484 rage systems lectric

LANGENKAMP, E.	The potential of energy farming for transport
The MARK-13 process for hydrogen production p0662 A80-48412	fuels in New Zealand, appendices [PB80-154255] p0693 N80-28573
LANGHORST, G. J. Preliminary study of the potential environmental	LEAR, J.  Hission analysis of the P78-2 power subsystem
concerns associated with surface waters and geothermal development of the Valles Caldera	after one year of operation , p0765 A80-48310
[LA-8398-MS] p0592,N80-33969 LANTS, L. J.	LEBERS, R. M.  Determining the optimum design of the solar
Solar index generation and delivery [DOE/BT-20090/3] p0654 H80-32929	modulator p0626 A80-52830
LAROCHE, U.  The usefulness of 'alternative' energy sources	LEBOROF, C. S. Solar ponds for district heating and electricity
from the economic and energetic point of view p0685 A80-50823	generation p0618 A80-48367
LARSBB, B. Bydrogen storage in magnesium powder	LEDER, P. Research needs for coal gasification and coal
D0664 A80-50623	liquefaction p0688 A80-53274
Power cycles analyses by generalized thermodynamic properties	LRE, A. L. Process evaluation: Steam reforming of diesel
P0725 A80-48250	fuel oil [AD-A087053] p0699 N80-30538
Pulsed measurement of solar cell spectral response p0604 A80-46737	LEE, D. D. Recovery of ethanol from fermentation broths using
LAU, P. S.  The HIGAS process to produce pipeline gas from coal	selective sorption-desorption p0678 A80-48516
p0674 A80-48291	LEE, J. D. Tandem mirror fusion-fission bybrid studies
HHD electrode development [FE-15529-5] p0748 N80-31222	[UCBL-84018] p0754 N80-33237 LEE, K.
LAURD, H.  Power generation from municipal and industrial  wastes with particular reference to sewage	Performance loss due to transient heat transfer in the cylinders of Stirling engines p0730 A80-48410
combustion p0685 A80-50815	LEE, W.  Mobil methanol-to-gasoline process
LAUGHLIN, R. G. W.  The Metor process for energy recovery from sewage	p0677 A80-48384 LBB, Y. C.
sludge and industrial waste streams	Linear analysis of the double-tearing mode p0718 A80-44390
LAUVERS, P. Influence of the double exponential on the	LEES, L. Research needs for coal gasification and coal
efficiency and the yield of screen printed solar cells	liquefaction p0688 180-53274
p0606 A80-46764	LEFFERT, C. B.
LAVI, A. Ocean thermal energy conversion - A general	Ultrasonic characterization of coal liquefaction products
LAVI, A.  Ocean thermal energy conversion - A general introduction p0718 A80-44599	Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-31503 LEFROIS, R. T.
LAVI, A.  Ocean thermal energy conversion - A general introduction p0718 A80-44599 Introducing OTEC to mainland utilities p0719 A80-44607	Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-31503 LEFROIS, B. T. Active heat exchange system development for latent heat thermal energy storage
Ocean thermal energy conversion - A general introduction p0718 A80-44599 Introducing OTEC to mainland utilities p0719 A80-44607 OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048	Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, B. T. Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGE, B. Thin film polycrystalline silicon solar cells
Ocean thermal energy conversion - A general introduction p0718 A80-44599  Introducing OTEC to mainland utilities p0719 A80-44607  OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048  LAVI, G. B.  Issues in OTEC commercialization	Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, R. T. Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGE, R. Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879  LEGGE, R. N.
Ocean thermal energy conversion - A general introduction p0718 A80-44599 Introducing OTEC to mainland utilities p0719 A80-44607 OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048 LAVI. G. H. Issues in OTEC commercialization p0719 A80-44606	Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-31503  LEPROIS, B. T.  Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGE, B.  Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879  LEGGE, B. N.  Potential for improved silicon ribbon growth through thermal environment control
Ocean thermal energy conversion - A general introduction p0718 A80-44599 Introducing OTEC to mainland utilities p0719 A80-44607 OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048 LAVI, G. B. Issues in OTEC commercialization p0719 A80-44606 LAVI, C. K. Combustion studies of coal-in-oil droplets [DDE/ET-10660/1] p0702 N80-31499	Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, R. T. Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGE, R. Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879  LEGGE, R. N. Potential for improved silicon ribbon growth through thermal environment control  LEHNAR, S. J.
Ocean thermal energy conversion - A general introduction p0718 A80-44599  Introducing OTEC to mainland utilities p70719 A80-44607  OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048  LAVI, G. B. Issues in OTEC commercialization p0719 A80-44606  LAWI, C. K. Combustion studies of coal-in-oil droplets	Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, B. T.  Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGE, B.  Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879  LEGGE, B. N.  Potential for improved silicon ribbon growth through thermal environment control  LEHNAM, S. J.  Coal gasification combined-cycle system analysis [EPRI-AP-1390] p0713 N80-33601
Ocean thermal energy conversion - A general introduction p0718 A80-44599  Introducing OTEC to mainland utilities p0719 A80-44607 OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048  LAVI, G. H. Issues in OTEC commercialization p0719 A80-44606  LAW, C. K. Combustion studies of coal-in-oil droplets [DOE/ET-10660/1] p0702 H80-31499  LAWRENCE, A. G. The use of solar energy for cooking p0659 N80-33953	Ultrasonic characterization of coal liquefaction products [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, R. T. Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGE, R. Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879  LEGGE, R. N. Potential for improved silicon ribbon growth through thermal environment control  LEHNAM, S. J. Coal gasification combined-cycle system analysis [EPRI-AP-1390] p0713 N80-33601  LEHEFELD, D. Stirling engine power system development and test results
Ocean thermal energy conversion - A general introduction  1	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, R. T.  Active heat exchange system development for latent heat thermal energy storage  [NASA-CR-159727] p0775 N80-29857  LEGGE, R.  Thin film polycrystalline silicon solar cells  [SAN-2207-T4] p0638 N80-29879  LEGGE, R. N.  Potential for improved silicon ribbon growth through thermal environment control  LEHMAR, S. J.  Coal gasification combined-cycle system analysis  [EPRI-AP-1390] p0713 N80-33601  LEHEFPELD, D.  Stirling engine power system development and test results
Ocean thermal energy conversion - A general introduction  1	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEPROIS, R. T.  Active heat exchange system development for latent heat thermal energy storage  [NASA-CR-159727] p0775 N80-29857  LEGGE, R.  Thin film polycrystalline silicon solar cells  [SAN-2207-T4] p0638 N80-29879  LEGGE, R. N.  Potential for improved silicon ribbon growth through thermal environment control  P0601 N80-46704  LEHMAR, S. J.  Coal gasification combined-cycle system analysis  [EPRI-AP-1390] p0713 N80-33601  LEHEPELD, D.  Stirling engine power system development and test results  p0731 N80-48453  LEIBBCKI, H. P.  Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data
Ocean thermal energy conversion - A general introduction p0718 A80-44599  Introducing OTEC to mainland utilities p0719 A80-44607 OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048  LAVI. G. H. Issues in OTEC commercialization p0719 A80-44606  LAWI. C. K. Combustion studies of coal-in-oil droplets p0702 N80-31499  LAWRENCE, A. G. The use of solar energy for cooking p0659 N80-33953  LAWRENCE, R. Effects of gasohol on idle HC and CO emissions p0590 N80-33018  LAWRENCE, R. J. Utilization of municipal refuse as an energy source p0714 N80-33952  LAWRENCE, V. F. Homentum transfer of laser radiation to	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEPROIS, B. T.  Active heat exchange system development for latent heat thermal energy storage  [NASA-CR-159727] p0775 N80-29857  LEGGR. R.  Thin film polycrystalline silicon solar cells  [SAN-2207-T4] p0638 N80-29879  LEGGE, R. N.  Potential for improved silicon ribbon growth through thermal environment control  LEHNAE, S. J.  Coal gasification combined-cycle system analysis  [EPRI-AP-1390] p0713 N80-33601  LEHRPELD, D.  Stirling engine power system development and test results  p0731 A80-48453  LEIBECKI, H. F.  Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis
Ocean thermal energy conversion - A general introduction p0718 A80-44599  Introducing OTEC to mainland utilities p0719 A80-44607 OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048  LAVI, G. H. Issues in OTEC commercialization p0719 A80-44606  LAW, C. K. Combustion studies of coal-in-oil droplets [DOE/ET-10660/1] p0702 N80-31499  LAWRENCE, A. G. The use of solar energy for cooking p0659 N80-33953  LAWRENCE, R. Effects of gasohol on idle BC and CO emissions [PB80-190655] p0590 N80-33018  LAWRENCE, R. J. Utilization of municipal refuse as an energy source p0714 N80-33952  LAWRENCE, V. P. Homentum transfer of laser radiation to inhomogeneous dielectrics p0737 A80-50356	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, B. T.  Active heat exchange system development for latent heat thermal energy storage  [NASA-CE-159727] p0775 N80-29857  LEGGE, B.  Thin film polycrystalline silicon solar cells  [SAN-2207-T4] p0638 N80-29879  LEGGE, B. N.  Potential for improved silicon ribbon growth through thermal environment control  DOE 10 10 10 10 10 10 10 10 10 10 10 10 10
Ocean thermal energy conversion - A general introduction  1	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, R. T.  Active heat exchange system development for latent heat thermal energy storage  [NASA-CR-159727] p0775 N80-29857  LEGGE, R.  Thin film polycrystalline silicon solar cells  [SAN-2207-T4] p0638 N80-29879  LEGGE, R. N.  Potential for improved silicon ribbon growth through thermal environment control  PO601 A80-46704  LEHMAR, S. J.  Coal gasification combined-cycle system analysis  [EPRI-AP-1390] p0713 N80-33601  LEHEFPELD, D.  Stirling engine power system development and test results  p0731 A80-48453  LEIBBCKI, H. F.  Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis  p0761 A80-46414  LENGYEL, L. L.  The feasibility of pellet re-fuelling of a fusion reactor
Ocean thermal energy conversion - A general introduction p0718 A80-44599  Introduction p0718 A80-44599  Introducing OTEC to mainland utilities p0719 A80-44607 OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048  LAVI, G. H. Issues in OTEC commercialization p0719 A80-44606  LAW, C. K. Combustion studies of coal-in-oil droplets [DOE/ET-10660/1] p0702 N80-31499  LAWRENCE, A. G. The use of solar energy for cooking p0659 N80-33953  LAWRENCE, R. Effects of gasohol on idle BC and CO emissions [PB60-190655] p0590 N80-33018  LAWRENCE, R. J. Utilization of municipal refuse as an energy source p0714 N80-33952  LAWRENCE, V. F. Homentum transfer of laser radiation to inhomogeneous dielectrics p0737 A80-50356  LAZARETH, O. W. Blanket options for high-efficiency fusion power p0729 A80-48360	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, B. T.  Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGE, B.  Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879  LEGGE, B. B.  Potential for improved silicon ribbon growth through thermal environment control  LEHNAE, S. J.  Coal gasification combined-cycle system analysis [FPRI-AP-1390] p0713 N80-33601  LEHRFELD, D.  Stirling engine power system development and test results  p0731 A80-48453  LEIBBCKI, H. F.  Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis  p0761 A80-46414  LENGYEL, L. L.  The feasibility of pellet re-fuelling of a fusion reactor  p0719 A80-44661  LENHARDT, B.  Energy models as a tool for planning
Ocean thermal energy conversion - A general introduction p0718 A80-44599  Introducing OTEC to mainland utilities p0719 A80-44607 OTEC power system modeling, analysis and design via geometric programming p0739 A80-52048  LAVI, G. H. Issues in OTEC commercialization p0719 A80-44606  LAW, C. K. Combustion studies of coal-in-oil droplets [DOE/ET-10660/1] p0702 N80-31499  LAWRENCE, A. G. The use of solar energy for cooking p0659 N80-33953  LAWRENCE, R. Effects of gasohol on idle HC and CO emissions [PB80-190655]  LAWRENCE, R. J. Utilization of municipal refuse as an energy source p0714 N80-33952  LAWRENCE, V. P. Homentum transfer of laser radiation to inhomogeneous dielectrics p0737 A80-50356  LAXARETH, O. W. Blanket options for high-efficiency fusion power p0729 A80-48360  LAXARET, G. L. I-V relationship for the Cu2S/CdS solar cell p0669 A80-46937	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEPROIS, B. T.  Active heat exchange system development for latent heat thermal energy storage  [NASA-CE-159727] p0775 N80-29857  LEGGE, B.  Thin film polycrystalline silicon solar cells  [SAN-2207-T4] p0638 N80-29879  LEGGE, B. N.  Potential for improved silicon ribbon growth through thermal environment control  DOE 10 N80-46704  LEHMAH, S. J.  Coal gasification combined-cycle system analysis  [EPRI-AP-1390] p0713 N80-33601  LEHRPELD, D.  Stirling engine power system development and test results  DO731 A80-48453  LEIBBCKI, H. P.  Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis  DO761 A80-46414  LENGYEL, L. L.  The feasibility of pellet re-fuelling of a fusion reactor  DO719 A80-44661  LENHARDT, N.  Energy models as a tool for planning  DO577 A80-54035  LENHARTE, R.
Ocean thermal energy conversion - A general introduction  1	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEPROIS, R. T.  Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGR. R.  Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879  LEGGE, R. H.  Potential for improved silicon ribbon growth through thermal environment control  LEHNAM, S. J.  Coal gasification combined-cycle system analysis [EPRI-AP-1390] p0713 N80-33601  LEHRPELD, D.  Stirling engine power system development and test results p0731 A80-48453  LEIBECKI, H. F.  Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis  p0761 A80-46414  LENGYEL, L. L.  The feasibility of pellet re-fuelling of a fusion reactor p0719 A80-44661  LENHARDT, M. Energy models as a tool for planning p0577 A80-54035  LENHARDT, R.  Strategies for rational utilization of bituminous coal deposits in the German Federal Republic
Ocean thermal energy conversion - A general introduction  10718 A80-44599  Introducing OTEC to mainland utilities 10719 A80-44607  OTEC power system modeling, analysis and design  Via geometric programming  1AVI, G. H.  Issues in OTEC commercialization  1AVI, C. K.  Combustion studies of coal-in-oil droplets [DOE/ET-10660/1]  The use of solar energy for cooking  LANREBCE, A. G.  Effects of gasohol on idle HC and CO emissions [PB60-190655]  LANREBCE, R. J.  Utilization of municipal refuse as an energy source p0714 N80-33952  LANREBCE, V. F.  Homentum transfer of laser radiation to inhomogeneous dielectrics  LANREBCE, O. W.  Blanket options for high-efficiency fusion power p0729 A80-48360  LANREW, G. L.  I-V relationship for the Cu2S/CdS solar cell p0669 A80-46937  LEACH, S. C. Direct electrochemical generation of electricity from coal [SAN-0115-105-1]  p0752 N80-32865	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, B. T. Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGE, B. Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879  LEGGE, E. N. Potential for improved silicon ribbon growth through thermal environment control  LEHNAM, S. J. Coal gasification combined-cycle system analysis [EPRI-AP-1390] p0713 N80-33601  LEHEFELD, D. Stirling engine power system development and test results p0731 A80-48453  LEIBECKI, B. F. Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis p0761 A80-46414  LENGYEL, L. L. The feasibility of pellet re-fuelling of a fusion reactor p0719 A80-44661  LENHARDT, E. Energy models as a tool for planning p0577 A80-54035  LENHARTE, R. Strategies for rational utilization of bituminous coal deposits in the German Federal Republic p0685 A80-50814
Ocean thermal energy conversion - A general introduction  1	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, B. T.  Active heat exchange system development for latent heat thermal energy storage  [NASA-CE-159727] p0775 N80-29857  LEGGE, B.  Thin film polycrystalline silicon solar cells  [SAN-2207-T4] p0638 N80-29879  LEGGE, R. N.  Potential for improved silicon ribbon growth through thermal environment control  DOE 10 N80-46704  LEHMAR, S. J.  Coal gasification combined-cycle system analysis  [EFRI-AP-1390] p0713 N80-33601  LEHRFELD, D.  Stirling engine power system development and test results  DO731 A80-48453  LEIBBCKI, H. F.  Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis  DO761 A80-46414  LENGYEL, L. L.  The feasibility of pellet re-fuelling of a fusion reactor  DO719 A80-44661  LEHHARDT, N.  Energy models as a tool for planning  p0577 A80-54035  LEHHARTZ, R.  Strategies for rational utilization of bituminous coal deposits in the German Federal Republic p0685 A80-50814  LENSKI, H.  Study on the utilization of solar energy for the operation of Spacelab material science furnaces
Ocean thermal energy conversion - A general introduction  1	Ultrasonic characterization of coal liquefaction products  [DOE/PC-10346/1] p0702 N80-31503  LEFROIS, B. T.  Active heat exchange system development for latent heat thermal energy storage [NASA-CR-159727] p0775 N80-29857  LEGGE, B.  Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-29879  LEGGE, B. H.  Potential for improved silicon ribbon growth through thermal environment control  LEHMAR, S. J.  Coal gasification combined-cycle system analysis [EPRI-AP-1390] p0713 N80-33601  LEHEFELD, D.  Stirling engine power system development and test results p0731 A80-48453  LEIBBCKI, H. F.  Cycles till failure of silver-zinc cells with competing failure modes - Preliminary data analysis  p0761 A80-46414  LENGYEL, L. L.  The feasibility of pellet re-fuelling of a fusion reactor p0719 A80-44661  LENHARDT, E.  Energy models as a tool for planning p0577 A80-54035  LENHARTZ, R.  Strategies for rational utilization of bituminous coal deposits in the German Federal Republic p0685 A80-50814  LENSKI, E.  Study on the utilization of solar energy for the

LENZ, S.	LEWIS, A.
Kiener pyrolysis, a link between waste disposal	Future aviation fuels - The petroleum industry
and energy supply	responds to the challenge [SAE PAPER 800769] p0680 A80-4971
p0682 A80-49983	LEWIS, C.
Hybrid lithium/nickel-zinc large missile ground power source	The potential role of biofuels within the built environment
p0772 180-48489	p0688 A80-5347
LEOR, R. Optical and calorimetric measurements of cupreous sulphides thin films	LEWIS, L. P. Thermal resource availability p0718 180-4460
p0607 A80-46779	LEWIS, P. P.
LEGEG, J. I.  Reactively sputtered thin film cu/sub r/S/CdS  photovoltaic devices	Coal processing for fuel cell utilization: Task 9: One-dimensional (streamtube) model for entrained-flow gasifier analysis
[UCID-18592] p0637 N80-29875	[METC-8450-T2-VOL-1] p0707 880-3191
Peat and wood as fuels - Another form of solar energy utilization	Chemical energy storage for solar thermal conversion [SAND-79~8198] p0652 B80-3288
p0671 A80-47595 LEROUX, H.	II. S. P. Induced junction solar cell and method of
AlSb as a candidate material for photovoltaic solar energy conversion	fabrication [NASA-CASE-NPO-13786-1] p0634 N80-2983
p0608 A80-46787	LI, S. S.
LERCY, D. J.  The thermodynamics of aqueous water electrolysis  p0664 A80-50511	<ul> <li>Effects of thermal annealing on the deep-level defects and I-V characteristics of 200 keV proton irradiated AlGaAs-GaAs solar cells</li> </ul>
LEROY, R. L.	p0613 A80-4820
The thermodynamics of aqueous water electrolysis p0664 A80-50511	LI, T. C. Cryogenic methane separation/catalytic
LESCARRET, A. S.  Miniplant and bench studies of pressurized	hydrogasification process analysis [PB-3044-T6] p0690 N80-2854
fluidized-bed coal combustion	LIRB, D.
[PB80-188121] p0712 N80-32999 LESCHLY, K. O.	Combustion performance of CVD silicon carbide thermionic diodes
Electric and hybrid vehicle system research and development project, hybrid vehicle potential	p0732 A80-4847. Thermionic converter output as a function of
assessment. Volume 8: Scenario generation [CONS-4209-T1-VOL-8] p0583 N80-31275	collector temperature p0732 A80-4847
LRSLIE, J. D.	LIEBERHAR, M.
Rconomic requirements for new materials for solar photovoltaic cells	Effect of refining variables on the properties and composition of JP-5
p0596 A80-45317	p0694 H80-2930 LIEDERMAN, D.
LESSAED, E. D.	
Coal-filed fluid bed compustion addmented	HODIA METHADOX-TO-QASQLIDE PROCESS
Coal-fired fluid bed combustion augmented compressed air energy storage systems	Mobil methanol-to-gasoline process p0677 A80-4838
compressed air energy storage systems p0768 A80-48376	p0677 A80-4838
compressed air energy storage systems p0768 A80-48376 LEGNG, C.	p0677 A80-4838
compressed air energy storage systems p0768 A80-48376 LEGHG, C. Study program for encapsulation materials interface for low cost silicon solar array	p0677 A80-4838 LIBB. S. H. Absorption refrigeration machine driven by solar heat [EUR-6748-EN] p0646 N80-3191
compressed air energy storage systems p0768 A80-48376  LEURG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32657	LIEB, S. H. Absorption refrigeration machine driven by solar heat [EUR-6748-BN] p0646 N80-3191 LIEB, H.
compressed air energy storage systems p0768 A80-48376  LBUBG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CE-163583] p0651 N80-32657  LBUBBHAGEB, J. I.	p0677 A80-4838  LIEM. S. H. Absorption refrigeration machine driven by solar heat [EUR-6748-EB] p0646 N80-3191  LIEM, H. The CO2 problem from the viewpoint of geoecology
compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32657  LBUEBBAGEB, J. I. An update on the City of Waukesha energy recovery incinerator plant	LIEM, S. H.  Absorption refrigeration machine driven by solar heat [BUB-6748-BH] p0646 N80-3191 LIEM, H.  The CO2 problem from the viewpoint of geoecology and energy economy p0575 A80-5082
compressed air energy storage systems p0768 A80-48376  LBUBG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CE-163583] p0651 N80-32657  LBUBBBAGBB, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591	LIEM, S. H.  Absorption refrigeration machine driven by solar heat [EUR-6748-EN] p0646 N80-3191  LIEM, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.
compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32657  LBUEBBAGEB, J. I. An update on the City of Waukesha energy recovery incinerator plant	LIEM. S. H.  Absorption refrigeration machine driven by solar heat [EUR-6748-EN] p0646 N80-3191  LIEM, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIM, H. C. Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program
compressed air energy storage systems p0768 A80-48376  LEUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CE-163583] p0651 N80-32657  LEVERBAGER, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LEVI, R. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947	p0677 A80-4838  LIEM. S. H.  Absorption refrigeration machine driven by solar heat [EUR-6748-EH] p0646 N80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program [DOE/CH-00178/T2] p0654 N80-3293
compressed air energy storage systems p0768 A80-48376  LBUBG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32857  LBVEBBAGEM, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBVI, R. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LEVIBB, E. P. Comparative assessment of environmental welfare	LIEM, S. H.  Absorption refrigeration machine driven by solar heat [EUR-6748-EN] p0646 N80-3191  LIEM, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIM, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program [DOE/CR-00178/T2] p0654 N80-3293  LIM, JT.  Wind resource assessment in the upper Skagit River
compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CE-163583] p0651 N80-32657  LEVERBAGER, J. I. An update on the City of Waukesha energy recovery incinerator clant p0670 A80-47591  LEVI. E. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LEVINE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SFS) and alternative technologies	LIEM, S. H.  Absorption refrigeration machine driven by solar heat [RUB-6748-BN] p0646 R80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program [DOE/CH-00178/T2] p0654 R80-3293  LIE, JT.
compressed air energy storage systems p0768 A80-48376  LBUBG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32857  LBVEBBAGEM, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBVI, R. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVINE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581 N80-30915	LIEM, S. H.  Absorption refrigeration machine driven by solar heat [EUR-6748-EN] p0646 N80-3191  LIEM, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIM, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program [DOE/CR-00178/T2] p0654 N80-3293  LIM, JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIM, R. J. H.
compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32857  LBVENBAGEN, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBVI, R. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVINE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOB/ER-0055] p0581 N80-30915 Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy	LIEM. S. H.  Absorption refrigeration machine driven by solar heat  [RUB-6748-BN] p0646 880-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CH-00178/T2] p0654 880-3293  LIE, JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIE, B. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation
Compressed air energy storage systems p0768 A80-48376  LBUBG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32657  LBVEBBAGEB, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBVI, E. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LEVIBE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SFS) and alternative technologies [DOE/ER-0055] Comparative analysis of het energy balance for Satellite Power Systems (SPS) and other energy systems	LIEM. S. H.  Absorption refrigeration machine driven by solar heat [EUR-6748-EN] p0646 N80-3191  LIEM. H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIM. H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program [DOE/CH-00178/T2] p0654 N80-3293  LIM. JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIM. R. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0619 A80-4820
Compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32857  LBVEBBAGEB, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBVI, E. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVIBE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SFS) and alternative technologies [DOB/ER-0055] p0581 B80-30915  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOB/ER-0056] p0582 N80-30916  LBVIBE, B.	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [RUB-6748-BN] p0646 R80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIM, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CH-00178/T2] p0654 B80-3293  LIM, JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIM, B. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  [DOE/CH A80-4820]  LIMCOT, D.  CdTe homojunctions solar cells
Compressed air energy storage systems p0768 A80-48376  LBUBG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32657  LBVENBAGEM, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBVI, E. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVINE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SFS) and alternative technologies [DOE/ER-0055] Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOE/ER-0056] p0582 N80-30916  LBVINE, B. Life cycle cost analysis in residential buildings and consumer appliances	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [EUR-6748-BN] p0646 N80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  [III, H. C.]  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOB/CH-00178/T2] p0654 N80-3293  LIM, JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIE, R. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIECOT, D.  CdTe homojunctions solar cells
Compressed air energy storage systems p0768 A80-48376  LBUNG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32657  LBUNGBBAGEN, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBUI, R. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBUINE, B. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOE/ER-0056] LBUINE, B. Life cycle cost analysis in residential buildings and consumer appliances  p0572 A80-48515	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [EUR-6748-EN] p0646 N80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CH-00178/T2] p0654 N80-3293  LIE, JT.  Wind resource assessment in the upper Skagit River valley of Washington  p0675 A80-4831  LIE, R. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIECOT, D.  Cdt homojunctions solar cells  p0603 A80-4673  LIED, H. A.  Properties of a solar alumina-borosilicate sheet glass
Compressed air energy storage systems p0768 A80-48376  LBUBG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32857  LBVEBBAGEB, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBVI, R. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVINE, B. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581 N80-30915  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOE/ER-0056] p0582 N80-30916  LBVINE, B. Life cycle cost analysis in residential buildings and consumer appliances p0572 A80-48515  LBVY-GARBOUA, V. The economics of energy prices - Doubts and	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [EUR-6748-BN] p0646 N80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  [III, H. C.]  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOB/CH-00178/T2] p0654 N80-3293  LIM, JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIM, R. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIBCOT, D.  CdTe homojunctions solar cells  P0603 A80-4673  LIED, H. A.  Properties of a solar alumina-borosilicate sheet glass  [SERI/TP-334-565] p0641 N80-3053
LBUBG, C.  Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32657  LBVEBBAGEB, J. I.  An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBVI. E.  Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVIBE, E. P.  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055]  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOE/ER-0056] p0582 N80-30916  LBVIBE, B.  Life cycle cost analysis in residential buildings and consumer appliances  p0572 A80-48515  LBVI-GARBOUA, V.  The economics of energy prices - Doubts and uncertainty	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [EUR-6748-EN] p0646 N80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CH-00178/T2] p0654 N80-3293  LIE, JT.  Wind resource assessment in the upper Skagit River valley of Washington  p0675 A80-4831  LIE, R. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIECOT, D.  Cdt homojunctions solar cells  p0603 A80-4673  LIED, H. A.  Properties of a solar alumina-borosilicate sheet glass  [SEEL/TP-334-565] p0641 N80-3053  LIEDHOLM, P. A.  Degradation of solar cell performance by areal
Compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32857  LBVEBBAGEB, J. I. An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LBVI, E. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVIBE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SFS) and alternative technologies [DOB/ER-0055] p0581 B80-30915  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOB/ER-0056] p0582 H80-30916  LBVIBE, B. Life cycle cost analysis in residential buildings and consumer appliances  p0572 A80-48515  LBVY-GARBOUA, V. The economics of energy prices - Doubts and ancertainty	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [RUB-6748-BH] p0646 N80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CE-00178/T2] p0654 N80-3293  LIE, JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIE, B. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIECOT, D.  CdTe homojunctions solar cells  Properties of a solar alumina-borosilicate sheet glass  [SEEI/TP-334-565] p0641 E80-3053  LIEDBOLH, F. A.
LBUEG, C.  Study program for encapsulation materials interface for low cost silicon solar array [NASA-CE-163583] p0651 N80-32657  LEVERBAGER, J. I.  An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LEVI. E.  Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LEVIEE, E. P.  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055]  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOE/ER-0056] p0582 N80-30916  LEVIEE, B.  Life cycle cost analysis in residential buildings and consumer appliances  p0572 A80-48515  LEVI-GARBOUA, V.  The economics of energy prices - Doubts and uncertainty  p0573 A80-49396  LEVI. P. P.  Liquid fuels production from biomass [COO-4388-10] p0708 N80-32545	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [EUR-6748-EN] p0646 N80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CH-00178/T2] p0654 N80-3293  LIE, JT.  Wind resource assessment in the upper Skagit River valley of Washington  p0675 A80-4631  LIE, R. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIECOT, D.  CdTe homojunctions solar cells  [SEEL/TP-334-565] p0641 N80-3053  LIEDHOLM, F. A.  Degradation of solar cell performance by areal inhomogeneity  p0624 A80-5111
Compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32857  LBVEBBAGER, J. I. An update on the City of Waukesha energy recovery incinerator plant  p0670 A80-47591  LBVI, E. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVIDE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SFS) and alternative technologies [DOB/ER-0055] p0581 B80-30915  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOE/ER-0056] p0582 M80-30916  LBVIDE, E. Life cycle cost analysis in residential buildings and consumer appliances  p0572 A80-48515  LBVY-GARBOUA, V. The economics of energy prices - Doubts and uncertainty  p0573 A80-49396  LBVY, P. P. Liquid fuels production from biomass [COO-4388-10]  LBW, V. The potential of energy farming in the	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [RUB-6748-BN] p0646 880-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CH-00178/T2] p0654 880-3293  LIE, JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIE, B. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIECOT, D.  CdTe homojunctions solar cells  LIED, H. A.  Properties of a solar alumina-borosilicate sheet glass  [SEEI/TP-334-565] p0641 880-3053  LIEDHOLM, F. A.  Degradation of solar cell performance by areal inhomogeneity  p0624 A80-5111  LIEDSTEOM, E. W.  Energy savings by means of fuel cell electrodes in electro-chemical industries
Compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32857  LBVERBAGER, J. I. An update on the City of Waukesha energy recovery incinerator plant  p0670 A80-47591  LEVI. E. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LEVINE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055] p0581 N80-30915  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOE/ER-0056] p0582 N80-30916  LEVINE, B. Life cycle cost analysis in residential buildings and consumer appliances  p0572 A80-46515  LEVIGARBOUA, V. The economics of energy prices - Doubts and uncertainty p0573 A80-49396  LEVI. P. P. Liguid fuels production from biomass [COO-4388-10] p0708 E80-32545  LEW. V. The potential of energy farming in the southeastern California desert [PE80-195019]	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [RUB-6748-BN] p0646 N80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOB/CB-00178/T2] p0654 N80-3293  LIE, JT.  Wind resource assessment in the upper Skagit River Valley of Washington p0675 A80-4831  LIE, R. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation p0614 A80-4820  LIECOT, D.  CdTe homojunctions solar cells  LIED, M. A.  Properties of a solar alumina-borosilicate sheet glass  [SEEL/TP-334-565] p0641 N80-3053  LIEDHOLM, F. A.  Degradation of solar cell performance by areal inhomogeneity p0624 A80-5111  LIEDSTROM, R. W.  Energy savings by means of fuel cell electrodes in electro-chemical industries  [COO-4881-12] p0745 N80-3090  LIEKORN, R.
Compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32857  LBVEBBAGER, J. I. An update on the City of Waukesha energy recovery incinerator plant  p0670 A80-47591  LBVI, E. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVINE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SFS) and alternative technologies [DOB/ER-0055] p0581 B80-30915  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOB/ER-0056] p0582 N80-30916  LBVINE, B. Life cycle cost analysis in residential buildings and consumer appliances  p0572 A80-48515  LBVY-GARBOUA, V. The economics of energy prices - Doubts and uncertainty p0573 A80-49396  LBVY, P. P. Liquid fuels production from biomass [COO-4388-10] p0708 E80-32545  LBW, V. The potential of energy farming in the soutneastern California desert [PB80-195019] p0714 E80-33921  LBW, W. B.	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [RUB-6748-BN] p0646 880-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CH-00178/T2] p0654 880-3293  LIE, JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIE, B. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIECOT, D.  CdTe homojunctions solar cells  LIED, H. A.  Properties of a solar alumina-borosilicate sheet glass  [SERI/TP-334-565] p0641 880-3053  LIEDHOLM, F. A.  Degradation of solar cell performance by areal inhomogeneity  p0629 A80-5111  LIEDSTROM, R. W.  Energy savings by means of fuel cell electrodes in electro-chemical industries  [COO-4881-12] p0745 880-3090  LIEKOBE, B.  Bickel hydrogen cell development centered on
LBUEG, C.  Study program for encapsulation materials interface for low cost silicon solar array [NASA-CE-163583] p0651 N80-32657  LEVERBAGER, J. I.  An update on the City of Waukesha energy recovery incinerator plant p0670 A80-47591  LEVI. E.  Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LEVIEE, E. P.  Comparative assessment of environmental welfare issues associated with the Satellite Power System (SPS) and alternative technologies [DOE/ER-0055]  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOE/ER-0056] p0582 N80-30916  LEVIEE, B.  Life cycle cost analysis in residential buildings and consumer appliances  p0572 A80-48515  LEVI-GARBOUA, V.  The economics of energy prices - Doubts and uncertainty  p0573 A80-49396  LEVI. P. P.  Liquid fuels production from biomass [COO-4388-10] p0708 N80-32545  LEV. V.  The potential of energy farming in the southeastern California desert [PB80-195019] p0714 N80-33921  LEV. E. B.  Potential of spark ignition engine, effect of	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [EUR-6748-EN] p0646 N80-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CH-00178/T2] p0654 N80-3293  LIE, JT.  Wind resource assessment in the upper Skagit River valley of Washington  p0675 A80-4631  LIE, B. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIECOT, D.  CdTe homojunctions solar cells  LIED, H. A.  Properties of a solar alumina-borosilicate sheet glass  [SERI/TP-334-565] p0641 N80-3053  LIEDDELM, P. A.  Degradation of solar cell performance by areal inhomogeneity  p0624 A80-5111  LIEDSTROM, R. N.  Energy savings by means of fuel cell electrodes in electro-chemical industries  [COO-4881-12] p0745 N80-3090  LIEKOBE, R.  Nickel hydrogen cell development centered on positive electrodes with high capacity per unit
Compressed air energy storage systems p0768 A80-48376  LBUEG, C. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CB-163583] p0651 N80-32857  LBVEBBAGER, J. I. An update on the City of Waukesha energy recovery incinerator plant  p0670 A80-47591  LBVI, E. Preliminary design for the power take-off of singly-loaded magnetohydrodynamic channels p0738 A80-50947  LBVINE, E. P. Comparative assessment of environmental welfare issues associated with the Satellite Power System (SFS) and alternative technologies [DOB/ER-0055] p0581 B80-30915  Comparative analysis of net energy balance for Satellite Power Systems (SPS) and other energy systems [DOB/ER-0056] p0582 N80-30916  LBVINE, B. Life cycle cost analysis in residential buildings and consumer appliances  p0572 A80-48515  LBVY-GARBOUA, V. The economics of energy prices - Doubts and uncertainty p0573 A80-49396  LBVY, P. P. Liquid fuels production from biomass [COO-4388-10] p0708 E80-32545  LBW, V. The potential of energy farming in the soutneastern California desert [PB80-195019] p0714 E80-33921  LBW, W. B.	LIEM, S. H.  Absorption refrigeration machine driven by solar heat  [RUB-6748-BN] p0646 880-3191  LIETH, H.  The CO2 problem from the viewpoint of geoecology and energy economy  p0575 A80-5082  LIE, H. C.  Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon impact program  [DOE/CH-00178/T2] p0654 880-3293  LIE, JT.  Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-4831  LIE, B. J. H.  High-efficiency concentration/multi-solar-cell system for orbital power generation  p0614 A80-4820  LIECOT, D.  CdTe homojunctions solar cells  LIED, H. A.  Properties of a solar alumina-borosilicate sheet glass  [SERI/TP-334-565] p0641 880-3053  LIEDHOLM, F. A.  Degradation of solar cell performance by areal inhomogeneity  p0629 A80-5111  LIEDSTROM, R. W.  Energy savings by means of fuel cell electrodes in electro-chemical industries  [COO-4881-12] p0745 880-3090  LIEKOBE, B.  Bickel hydrogen cell development centered on

LOTT, D. R. Carbohydrate crops as a renewable resource for fuels production. Volume 3: Juice preservation [BMI-2031-VOL-3] p0696 M80-29511 An evaluation of spectrally selective reflectors (cold mirror membranes) for use with concentrator solar arrays LIPPERT, T. B. p0659 N80-33900 Open-cycle MHD systems analysis [EPHI-AP-1316] LOWBET. J. R. p0753 N80-32881 Thermelectric materials for solar energy conversion LISTER, D. B.
Review of Department of Energy sponsored codes and documentation available from Purdue and Lehigh p0631 N80-28669 [AD-A084948] Industrial energy conservation with the natural gas-fueled molten carbonate fuel cell [K/CSD/TH-35] p0571 A80-48280 LITCHPIBLD, J. H. Carbohydrate crops as a renewable resource for fuels production. Volume 3: Juice preservation Pseudo-shock as a qualitative model in the investigation of the influence of wall roughness on the performance of supersonic MBI generators [AD-A088333] p0754 M80-33 [BHI-2031-VOL-3] p0696 880-29511 LITTAGER, E. L. p0754 N80-33228 Development of a lithium-water-air primary battery p0768 a80-48372 LOCARRLLI, P. B., JR.
California's biomass and its energy potential [LBL-10058] p0709 N80-32564 Porm factor for certain types of toroidal solenoids LUCHIBIB, A. G. p0721 A80-47230 Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in Convective-radiative interaction in a parallel large tokamaks plate channel - Application to air-operated p0738 A80-51038 solar collectors LUCK. B. M. p0598 A80-46349 Collector sealants and breathing LIU, C. T. [ DOB/CS-15362/1] p0650 N80-32527 Performance and structural characteristics of the iron-air battery system LUDOWISE, M. J.
High-efficiency AlGaAs/GaAs concentrator solar p0767 A80-48371 cells by organometallic vapor phase epitaxy p0610 A80-46952 Some characteristics of low-cost silicon sheet LUDRIG. P. L A practical and economic method for estimating wind characteristics at potential wind energy p0605 A80-46756 LIUTOVICE. A. S. Some electric and photoelectric properties of conversion sites photodetectors based on epitaxial layers Si/x/Ge/1-x/ with diffused p-n junction p0670 A80-46569 LUB. J. W. Advanced designs for highly stable superconductor p0610 A80-47153 Some electric and photoelectric properties of photodetectors based on epitaxial layers systems [CONF-791102-148] p0748 N80-31253 Si/x/Ge/1-x/ with diffused p-n junction Worldwide survey of current experience burning p0610 A80-47153 residual and crude oils in gas turbines [EPRI-AF-1243] p069. p0693 N80-28724 LLABRES. J. Optical and calorimetric measurements of cupreous LUMSDAINE, B. Cassegrain solar concentrators for photovoltaics sulphides thin films p0607 A80-46779 p0608 A80-46791 Simple design calculation procedure for passive Solar radiation incident on tilted flat surfaces solar houses D0627 A80-52839 LUMSDAIME, M. Simple design calculation procedure for passive p0625 A80-51684 LOBBERE. R. I. Performance of an inlet manifold for a stratified solar houses storage tank
[ASME PAPER 79-HT-67] p0627 A80-52839 LUNDENO, C. p0597 A80-45728 Safety of wind energy conversion systems (WECS): Preliminary study LOBRCHER, H. Reduction of fuel consumption by thermodynamic optimization of the Otto motor: Comparative investigation of Otto diesel engines
[EUR-6711-DE] p0585 M80-[ PFA-HU-2126] p0742 N80-28933 LUBSDEN, J. B., III
Study program for encapsulation materials p0585 N80-32733 interface for low cost silicon solar array
[NASA-CR-163583] p0651 N80-32857 R. H. Advanced coal liquefaction processes emphasize low LUQUE, A. hydrogen consumption multijunction cells for double-sided concentrated illumination p0676 A80-48380 Development research program for clean industrial and transportation fuels from coal [PE-2514-31] p0691 M80-28 p0691 N80-28554 p0606 A80-46768 LOO, B. 1. Effects of thermal annualing on the deep-level LURIE, C. Application of battery reconditioning techniques to achieve capacity restoration - A case history p0769 a80-48397 defects and I-V characteristics of 200 keV proton irradiated AlGaAs-GaAs solar cells LUSTABADER, R. L. Regenerative flywheel energy storage system p0613 A80-48204 Development of space-qualified Gals solar cells p0658 #80-33888 [ UCRL-13982-REV-1 ] p0775 N80-28684 LUTUACK, R. Assessment of sulfur removal processes for Low cost processes for silicon advanced fuel cell systems [EPRI-EM-1333] p0606 A80-46757 p0752 N80-32866 LYCZKOWSKI, R. W. Heat transfer - San Diego 1979; Proceedings of the Bighteenth National Conference, San Diego, Calif., August 5-8, 1979 Eigenvalue bounds for Hill's equation p0720 A80-45851 The first realistic solar energy project LYNN, D. K. Fuel cell systems for vehicular applications [SAE PAPER 800059] p0736 A p0758 A80-50994 p0736 A80-49720

LYON, E. P. The 100-kmp photovoltaic power systematic pow	em at Batural	A computer model for polycrystalline solar cells	
Bridges Mational Honument	p0615 A80-48227	HALBITA, G.	p0606 A80-46
LYON, B. J. F. Geological and geothermal data use:	investigations	n-CdS/p-Si heterojunction solar cell	ls p0626 <b>A80-</b> 52
for application Explorer mission-		HALPUSKII, IU. M.	-
	p0698 #80-29822	Estimating capacity of solar thermos generator /STEG/ panels	
LYOUS, J. Start-up consideration in utility u	se of a refuse	HALLON, B. G.	p0610 A80-47
derived fuel	. p0673 A80-48276	Economics of shale oil production by frequency heating	7 radio p0710 B80-32
M		[UCBL-52942] MALONE, G. A. Peasibility study: Puel cell cogene	-
HAASVINKEL, A. G. R.		water pollution control facility,	volume 1
Reflectance measurements on laser-part of the second at 0.26 micron	roduced plasmas	[DOB/ET-12431/T1-VOL-1] HALOHEY, T. J.	p0749 B80-31
	P0741 A80-53870	High-efficiency AlGaAs/GaAs concents	
Temperature limitations of alkaline electrodes	battery	cells by organometallic vapor phas	p0610 A80-46
•	p0766 A80-48330	Twenty years of experience with well	
Bovironmental implications of electrons	ric utility	heat pumps at Battelle's Columbus	p0733 A80-48
supply plans, 1978-2000 [PB80-192156]	p0588 #80-32963	MALSBERGER, R. R. Engineering prototype studies on the	
MACIOCE, L. B.  The energy efficient engine project		chemical heat pump for solar air o heating, and storage	conditioning,
[NASA-TH-81566] MADDOCK, B. J.	p0585 #80-32395	HAMABE, I.	p0616 A80-48
Large-scale electrical energy storage	ge p0761 <u>1</u> 80-44241	Pormation of sulfate particles in the Pour Corners Power Plant	e plume of th
MARS, J. W. C.  The influence of grain size and dops	ant.	BAMAETOV, G.	p0576 A80~51
concentration on the electrical property polycrystalline silicon films		A new rechargeable high voltage low molten salt cell	temperature
,	p0600 A80-46696		p0764 A80~48
The stability of amorphous silicon Schottky-barrier solar cells		HABAKER, A.  Near term commercialization of MHD p  generation using coal/oil fuel	over
•	p0602 A80-46722		p0724 A80-48
High performance photovoltaic system	rs p0616 180-48233	MANASEVIT, H. H. Thin films of InP for photovoltaic e [COO-3004-2]	nergy convers p0642 B80-30
MAGHSOOD, J.  Heating requirements and estimations	g of solar	#ANASSEM, J. Photoreduction of carbon dioxide and	l water into
energy available in Iran	p0620 A80-48792	formaldehyde and methanol on semic materials	
MAHAH, J. B.	•		p0621 A80-48
Distributed series resistance in ph devices - Intensity and loading e	ffects p0624 A80-51118	Photoelectrochemistry with p-Si electrochemistry	p0737 A80-50
MAHATO, B. K.	_	HARCUSO, B. L.	
Lead-acid battery expander. I - Elec evaluation techniques	p0761 A80-47137	A practical and economic method for wind characteristics at potential conversion sites	
MASSPREY, B. 2-	_		p0670 A80-46
Transient thermal analysis of phase energy storage systems	change thermal	Utilization of low temperature insul	lators and
MARRERY, T.	p0762 A80-48001	seals in thermionic converters	p0732 A80-48
· Future space power - The D.O.D. per	spective p0722 A80-48174	MANHIRE, B. A new probabilistic simulation techn	=
Air Force space power technology pro		multiple energy storage devices for utility generation system expansion	r electric
MASSESSOLS, 6. J. Potential displacement of petroleum	imports by	models	p0774 N80-28
solar energy technologies	p0656 N80-32959	HAMISCALCO, J. A.	· •
[SEEI/TE-352-504]  MAIDEN, B.  Photovoltaic institutional issues s	-	An engineering development plan for confinement fusion	r0733 A80-48
[SAND-79-7054]	p0584 N80-31950	HANK, B. H.	
MAIRE, R. W. Refinery energy profile	-AE77 NOA-20057	Some chemistry in the Li/SOC12 cell	p3774 A80-51
[ORO-5262-5-SUPPL] HAKAROV, IU. V.	p0577 #80-28857	MANN, J. A. Multi-hundred kw solar arrays for sp	
Bnd zone of a frame-type channel wi inhomogeneous flow		MANSPELD, P. B.	p0617 A80-48
Makibara, J.	p0739 A80-52555	Study program for encapsulation mate interface for low cost silicon sol	erials Lar arrav
A methodology for the environmental advanced coal extraction systems	assessment of	[NASA-CR-163583] MANYI, R.	p0651 180-32
[NASA-CR-163570] HAKRAH-BBEID, S.	p0586 N80-32827	Thermal buffering of receivers for p solar thermal power plants	arabolic dish
Early assessment of the photovoltaid		position than the party branch	p0618 A80-48
potentialities of BAD polysilicon	sheets 50600 A80-46701	•	

lel for polycrystalline Si n/plus//p p0606 A80-46766 erojunction solar cells p0626 A80-52498 . pacity of solar thermoelectric STEG/ panels p0610 A80-47155 shale oil production by radio ating p0710 H80-32566 tudy: Puel cell cogeneration in a tion control facility, volume 1 31/T1-VOL-1] p0749 880-31922 y AlGals/Gals concentrator solar managements of the solar managements o p0610 A80-46952 of experience with well-water-source at Battelle's Columbus Laboratories p0733 A80-48481 cototype studies on the CaCl2-CH3OH at pump for solar air conditioning, storage D0616 A80-48289 sulfate particles in the plume of the Power Plant p0576 A80~51660 able high voltage low temperature cell p0764 A80-48237 ercialization of MHD power using coal/oil fuel p0724 A80-48225 InP for photovoltaic energy conversion p0642 N80-30912 of carbon dioxide and water into and methanol on semiconductor p0621 A80-48923 emistry with p-Si electrodes nversion p0737 A80-50760 nd economic method for estimating teristics at potential wind energy p0670 A80-46569 low temperature insulators and ermionic converters p0732 A80-48474 istic simulation technique for ergy storage devices for electric eration system expansion planning p0774 N80-28855 development plan for inertial fusion r0733 A80-48496 in the Li/SOC12 cell p3774 A80-51688 kw solar arrays for space p0617 A80-48355 for encapsulation materials or low cost silicon solar array 3583] p0651 N80-32857

p0618 A80-48419

MANZONI, 6. C. Integration of photovoltaic generat	ion into a	MARTIN, J. K.	
large generating system		An energy and cost analysis of resid pumps in northern climates	
MAO, B. I.	p0604 A80-46743	MARTIN, T. H.	p0571 A80-48426
A multiple p-n junction structure of as-grown Czochralski silicon crys	tals by heat	Pulsand-80-0550C]	
treatment - Application to solar	cells p0595 A80-45121	MARTIMBAO, T. Photovoltaic institutional issues st	•
MARASSI, E.	_	[SAND-79-7054]	p0584 N80-31950
A new rechargeable high woltage low molten salt cell	p0764 A80-48237	Characterization of open-cycle, coal	-fired MHD
MARCHAUT, L. C. Recent activity in U.S. tar sand	p0104 R00-40231		p0750 N80-31936
MARCUS, C. J.	p0671 A80-48166	Characterization of open-cycle, coal generators	
Thermal buffering of receivers for solar thermal power plants	parabolic dish	[ARI-RP-46]  MARTINI, W. R.  Validation of published Stirling eng	p0751 N80-32234
MARPAING, Y.	P0618 A80-48419	methods using engine characteristi	
Evaluation of multijunction structu	res using		p0734 A80-48497
amorphous Si-Ge alloys	p0602 A80-46719	EARTING, P. J.  Cycle life studies of LiAl/FeS cells	neina BN folt
CdTe homojunctions solar cells	p0603 A80-46731	separators	p0763 A80-48189
MARGADONNA, D. n-CdS/p-Si heterojunction solar cel		Optimization studies of lithium/iron	sulfide cells
	p0626 A80-52498	for electric vehicle applications	p0763 A80-48190
MARGULIES, A. B. Thermionic topping of combined cycl	e novernlants	MARTIMOT, H. Accurate computer analysis of solar	colle
and cogeneration applications	•	including band-gap variation - App	
MARIANI, B.	p0730 A80-48423	the Al/x/Ga/1-x/AsGaAs structure	p0607 180-46782
Assessment of Peruvian biofuel reso alternatives	ources and	MAROSAK, T. J.  Development of a diaphragm Stirling	£.2
[ANL/BES/TH-86]	p0708 N80-32547	heat-actuated heat pump	•
HARK, S. D., JR. Recent developments in a slagging p	rocess for	HARUSKA, H. P.	p0731 A80-48425
conversion of refuse to energy	p0682 A80-49981	Theory of polycrystalline silicon so Effect of reduction in grain bound recombination states	
An investigation of the thermal ene		•	p0597 A80-46258
capacity of Glauber's salt with r thermal cycling	_	MASSEJIAN, J. Induced junction solar cell and meth	od of
MARKS, S. B.	p0774 A80-51683	fabrication [NASA-CASE-NPO-13786-1]	p0634 N80-29835
Thermal energy storage using Glaube Improved storage capacity with th	ermal cycling	MASOE, C. P. V.  Hydrogen production from the solar b	
MARKSBERRY, C. L.	p0764 A80-48197	cadmium cycle	p0662 180-48416
Development of the high temperature	air heater for	MASSEE, P.	
open cycle MHD	p0724 A80-48224	The dispersion relation of electroth a nonequilibrium magnetohydrodynam [TH-78-B-92]	
Constraints on carbon dioxide produ	ction from	HASSON, H.	7 1 ,
fossil fuel use [OBAU/IBA-80-9(M)]	p0589 N80-32983	Wood waste gasification as a source	of energy p0679 A80-49540
MARSHALL, R. E.	_	MASTERSON, K. D.	-
Simplified energy design economics: economics applied to energy conse	rvation and	National solar optical materials pro	
solar energy investments in build [PB80-179245]	p0634 N80-29534	[SERI/TP-641-619] HATHUR, A. K.	p0639 N80-29892
HARSHALL, E. P. performance of a diesel engine oper	ating on raw	Active heat exchange system developm heat thermal energy storage	ent for latent
coal-diesel fuel and solvent refi		[ NASA-CR-159727 ]	p0775 N80-29857
fuel slurries [CONS-3288-T6]	p0701 N80-30758	HATHUR, M. P.  Recent coal-oil mixture combustion t	ests at PETC
MARSHALL, J. E. Canadian biomass perspective - A ne	w interest in	[DOE/PETC-TR-80/5] HATRUR, R. S.	p0706 N80-31658
an old fuel	p0687 A80-52856	The power system	p0743 N80-29387
HARSTON, C. H.	-	HATSUHOTO, Y.	•
Parametric study of prospective ear OCMED power plants /FSPEC/		Visible light response of polycrysta electrodes	· .
MARTIE, B. G.	p0717 A80-44106	MATSURAGA, M.	p0664 A80-51691
A new diffusion process for silicon	solar cells	A new rechargeable high voltage low	temperature
MARTIE, J. P.	p0601 A80-46708	molten salt cell	p0764 A80-48237
Simulation and evaluation of latent energy storage heat pump systems	heat thermal	MATSUO, T. Man-made molecular assemblies for en	O TA V
Thermal energy storage for building	p0771 A80-48478	conversion from light into chemical	
cooling applications		BATTEO, B.	_
[ORML/TM-7319]	p0777 #80-32879	Design, construction, and operation solar-powered irrigation facility, [ALO-4159-1]	

<b>***</b>	
Survey of selective solar absorbers and their	Preparation and stability of enulsions of methanol
limitations	in automotive diesel oil
[SAHD-79-2371C] p0639 H80-29889 HATULEVICIUS, B. S.	[PB80-169162] p0697 N80-29526 Preparation and stability of emulsions of methanol
Miniplant and bench studies of pressurized fluidized-bed coal combustion	in automobile diesel oil [CSIR-CEMG-294] p0713 M80-33579
[PB80-188121] p0712 880-32999	ACCOBAICK, J. B.
The CS/R advanced SHG hydrogasification process	The case for fuel-cell-powered vehicles p0721 A80-47100
p0674 A80-48292	Puel cell systems for vehicular applications
HAX, C. B. A model for laser driven ablative implosions	[SAE PAPER 800059] p0736 A80-49720
p0735 A80-49069	Coal gasification/gas cleanup test facility:
MAY, E. E. Potential for supplying solar thermal energy to	Volume 1. Description and operation [PB80-188378] p0707 #80-31990
industrial unit operations [SERI/TP-632-584] p0588 N80-32911	MCDANIEL, C. V. Catalyst development for coal liquefaction
MAYO, J. W. Status of electrochemical energy storage systems	[EPRI-AF-1233] p0696 H80-29508 BCDERHOTT, P. P.
for electric vehicle, solar, and electric utility applications	An accelerated test design for use with synchronous orbit
p0765 A80-48325	p0770 A80-48401
MARABDARIET, F. B. Development of molten carbonate fuel cells for	HCDOHALD, C. P.  The HTGE-GT closed-cycle gas turbine - A plant
power generation p0726 180-48279	concept with inherent cogeneration /power plus heat production/ capability
MARRE, J. A.	p0724 A80-48248
Degradation of solar cell performance by areal inhomogeneity	MCDONALD, B. W. Hybrid litbium/nickel-zinc large missile ground
p0624 A80-51112	power source p0772 A80-48489
A hybrid water-splitting cycle using copper sulfate and mixed copper oxides	HCRLHAB, J. A. High energy density composite flywheel program
p0664 A80-48503	[AD-A087076] p0777 N80-31892
Numerical modelling of a solar cell in three	The fate and effects of crude oil spilled on
dimensions p0605 A80-46749	subarctic permafrost terrain in interior Alaska [PB80-187305] p0585 B80-31984
HCALEVY, R. P., III Flywheel-transmission characteristics required for	BCPARLAND, R. Performance estimates for attached sunspace
break-even impact on automotive vehicle performance	passive solar heated buildings [LA-UR-80-853] p0642 H80-30913
p0768 A80-48378	MCFARLAND, B. D.
ECALISTER, A. J. Materials for fuel cells	The effect of design parameter changes on the performance of thermal storage wall passive
[PB80-182355] p0748 N80-30955	systems p0626 A80-52829
ECAULAY, J. E. Improved components for engine fuel savings (MASA-TH-81577) p0583 880-31402	A semi-empirical method for estimating the performance of direct gain passive solar heated
MCBREE, J.	buildings p0627 A80-52838
Improved alkaline hydrogen/air fuel cells for transportation applications	MCGAULEY, P. J.
p0726 A80-48282	An engineering study on the use of regenerative
Fuel cell applied research: Electrocatalysis and naterials	calcium silicates sorbent for AFB power generation from high sulfur coal
[BNI-51072] p0744 N80-29885	p0672 A80-48171
Parabolic trough solar collector wind loading	MCGINBIS, R. Production of photovoltaic devices
[SAND-79-2134C] p0652 N60-32895	[ASE PAPER 79-SOL-8] p0596 A80-45662
Electrochemical Orbital Energy Storage (ECOES)	Continued evaluation of compact heat exchangers
technology program p0780 H80-33473	for OTEC evaluation [COO-4238-14] p0750 #80-31945
MCCABE, J. T. Assessment of Synthane mechanical equipment	School veb process development
[HTI-79TR5] p0710 H80-32572	[HASA-CH-163386] p0631 H80-28864
Shift conversion and methanation in coal	MCINTIRE, W. R. New reflector design which avoids losses through
gasification: Bench-scale evaluation of a sulfur resistant catalyst	gaps between tubular absorbers and reflectors p0625 A80-51678
[PE-3240-T4] p0692 N80-28561	MCKRE, C. P.
Shift conversion and methanation in coal gasification: Bench-scale evaluation of a	A model for laser driven ablative implosions p0735 A80-49069
sulfur resistant catalyst [FE-3240-T5] p0696 H80-29509	MCKEE, C. B.  The push-pull test - A method of evaluating
ECCARTY, P. L. Peasibility of a peat biogasification process	formation adsorption parameters for predicting the environmental effects on in-situ coal
p0669 A80-46197	gasification and uranium recovery
Screening method for wind energy conversion systems	p0576 A80-52968
[SERI/TP-731-649] p0744 880-29891	Sulfate in diesel exhaust
ACCORER, K. H.  Hydrogen production by the GA sulfur-indine process	p0575 A80-50528
Hydrogen production by the GA sulfur-iodine process [GA-A-15777-REV] p0666 B80-31651	Electrical power subsystem for INSAT-I
HCCORKIE, R. H., JR. High-temperature thermochemical water splitting	p0616 A80-48308
cycle fusion reactor design considerations	
P0663 A80-48449	•

MCRUBRE, M. C. H. MENZIES, W. B. Temperature limitations of alkaline battery Stack gas reheat evaluation [PB80-196850] p0593 N80-33980 electrodes p0766 A80~48330 MERCHANT, B. C. ECEBBER, G. H. Concentrators and solar photovoltaics Automatic-control system for the 17-metre Vertical p0622 A80-50626 Axis Wind Turbine (VAWT) MERDINGER, M.
H-Coal processing of Kentucky No. 11 coal and 1980 [SAND-78-0984] p0750 #80-31958 status of H-Coal .HCNOWN, B. P. Potential displacement of petroleum imports by solar energy technologies [SEEI/TE-352-504] p0656 M80p0677 A80-48429 MRROBEY, R. B. p0656 N80-32959 Sites for wind-power installations: Physical ECVEY, J.

Collector temperature effects on the performance of advanced thermionic converters and nuclear modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Executive summary Part 1: p0706 E80-31900 Sites for wind-power installations: Wind characteristics over ridges, part 2.
[BLO-2438-78/21 D0730 A80-48421 MBAD, W. C. A model for laser driven ablative implosions p0735 A80-49069 BERRICK, D. HEADER, 8. D.
Test evaluation of a prototype 18-ton solar powered heating and cooling system Coal-fired fluid bed combustion augmented compressed air energy storage systems D0768 A80-48376 p0619 A80-48480 BERTENS, R. BIS and SIS solar cells on polycrystalline silicon p0597 A80-46257 Experimental optimization of the efficiency of HEADOR, J. S. Establishment of parameters for production of long life nickel oxide electrodes for nickel-hydrogen n/+/-p-p/+/ and p/+/-n-n/+/ silicon solar cells D0771 A80-48445 p0601 A80-46706 Photovoltaic generators using optical concentration MRANS. J. C. Sorption properties of sediments and p0604 A80-46739 energy-related pollutants [PB80-189574] Influence of the double exponential on the efficiency and the yield of screen printed solar p0589 N80-32997 HEEK. J. The HYGAS process to produce pipeline gas from coal p0674 A80-48291 p0606 A80-46764 Hybrid thermal-photovoltaic systems MRHALICE, B. H.

Design of a photovoltaic system for a southwest
all-electric residence p0628 A80-52865 MESKO. J. B. Economic analysis of coal burning fluidized bed [SAND-79-7056] steam and by-product power generation systems for industrial facilities p0637 N80-29876 BRHTA. G. D. Laboratory demonstration of self-creation, self-maintenance and self-correction of p0672 A80-48200 Helium-topping/organic bottoming - Advanced power saturated solar ponds generation system Exergetic/energetic analysis D0618 A80-48366 p0673 A80-48247 Development of sodium sulfur batteries The operating region of MHD generators [BHFT-FB-T-79-60] -p0739 A80-51721 D0776 N80-29905 Salton Sea solar pond project Ground coupled solar heat pump research program in p0617 A80-48362 the United States [BNL-27383] p0636 N80-29867 Recent developments in a slagging process for MBYRD, T. O.
The Intelsat V nickel- cadmium battery system conversion of refuse to energy D0682 A80-49981 p0769 A80-48395 EELIRIAN, G.
Test evaluation of a prototype 18-ton solar powered heating and cooling system HEZZIBA, A.

Bydrogen production from remote power sites [BNL-27457] p0666 N80-32553 MICHABLIS, B. M. D0619 A80-48480 MRLLER, B.
The remaissance of coal Solaser power p0622 A80-50627 MICHEL, J. p0689 A80-54036 MENDRISOND, 8. A.
Collector sealants and breathing A new diffusion process for silicon solar cells p0601 A80-46708 [ DOE/CS-15362/1] p0650 N80-32527 MBBBBBB, S. Condenser designs for binary power cycles p0723 A80-48221 Photoelectrochemical compatibility of n-WSe2 and n-MoSe2 with various redox systems MICKELSEN, R. A. p0610 A80-47141 Emerging materials systems for solar cell MENGEL, B. W.
Photovoltaic applications definition and applications: Cu/sub 2-x/Se [DOE/ET-23005/T3] D0632 N80-28895 photovoltaic system definition study in the agricultural sector. Volume 2: Technical results HIDBOE, E. A.
U.S. Department of Energy ocean waves and ocean [SAND-79-7018/2-VOL-2] p0586 M8
Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes p0586 N80-32870 currents energy conversion programs - An overview p0740 A80-53678 MIRSTEE, A. P. Development of molten carbonate fuel cell power [SAND-79-7018/3] p0652 N80-32891 plant technology [DOE/ET-15440/1] MRHSE, 1. T.

Neutral-beam energy and power requirements for expanding-radius and full-bore start-up of p0750 N80-31938 MIGLIARESI, C.
The development of thermal energy storage systems tokamak reactors exploiting solid-solid phase transitions D0719 A80-44656 D0774 A80-50970 Total and non-isotropic diffuse insolation on n-CdS/p-Si heterojunction solar cells p0626 A80-52498

p0599 A80-46571

tilted surfaces

p0726 A80-48270

	•		
MIRBAIL, A. S.		MILWES, A. G.	
Analytical studies of wind turbine t	urning	Theoretical performance of multi-layer	er grid
characteristics frio-2439-79/31	-07E2 #80 220E4	patterns for solar cells	-060E 100 467E2
[RLO-2439-79/3] HIKKOR, H.	p0753 #80-32951	Predicted effect of grid line aspect	p0605 180-46752
Volume optimization of sodium-sulfur	hatteries	performance of solar cells	Tatto on the
using various advanced cell concep		berrorannee or porar cerra	p0625 A80-51687
	p0764 A80-48236	AINETTI-AESSETTI, B.	
MILDICE, J. E.	•	A solar thermophotovoltaic converter	
Power management for multi-100 KWe s			p0597 A80-46256
	P0758 A80-48357	MINOR, J. R.	
Study of power management technology		Seasonal thermal energy storage	
multi-100kWe applications. Volume	J:	[PNL-3322]	p0778 #80-32899
Requirements	-A750 NOA-20005	HISKOLCHY, G.	
[HASA-CR-159834] HILEY, G. H.	p0759 #80-29845	Thermionic topping of combined cycle	powerplants
Direct energy conversion for fusion	DONAL	and cogeneration applications	p0730 A80-48423
Direct chery; conversion for resion	p0729 A80-48361	Combustion performance of CVD silicon	
The Spheromak fusion reactor	F 201 10301	thermionic diodes	
•	p0733 &80-48495		p0732 A80-48473
MILIHKOVIC, L. S.	-	HITCHELL, J. W.	-
Hybrid system consisting of silicon with concentrators and heat pump	solar cells	A design method for parallel solar-he	eat pump systems p0621 A80-48922
	p0608 A80-46792	MITTAL, M. L.	
MILLER, A. H.	•	End effects in a MHD channel with div	rerging
Implications of the effects of wind		electrode walls	-0720 200 50000
characteristics on the operation of turbines	r rarde Aluq	#****	p0738 A80-50948
rat bings	p0727 A80-48321	Pollutants from synthetic fuels produ	ction. Cost
Wind characteristics program element		gasification screening test results	
[PHL-3211]	p0754 980-33073	[PB80-182769]	p0707 N80-31986
MILLER, B.		MIXON, W. R.	*****
Photoelectrochemical compatibility of	f n-WSe2 and	Development of an energy consumption	and cost data
n-MoSe2 with various redcx systems		base for fuel cell total energy sys	
	p0610 A80-47141	conventional building energy system	
MILLER, C. L.			p0754 N80-32960
The U.S. coal gasification program -	Progress and	HITAHOTO, K.	
projects	-0670 NO#633E	Solar energy conversion through bioph	
The direction and scope of the U.S.	p0670 A80-46325		p0666 N80-31927
Energy's surface coal gasification		Physical/chemical modeling for photon	oltaic module
	p0672 A80-48242	life prediction	
MILLER, P. Q.	•		p0608 A80-46790
Design, performance and life cycle c		MODELLI, A.	-
relationships for a 500km space so		High efficiency silicon solar cell for	r
******* **	p0617 A80-48356	concentrator systems	-0606 100 46363
MATIONAL Passive Solar Conference, 3:	rd fan Jose	MORLLER, U.	p0606 A80-46767
Calif., January 11-13, 1979, Proceed		The usefulness of 'alternative' energ	A SUBLCES
	p0626 A80-52826	from the economic and energetic poi	
MILLER, J. R.			p0685 A80-50823
Advanced designs for highly stable s	uperconductor	HOPPITT, R. D.	-
systems		Large-scale electrical energy storage	,
[CONF-791102-148]	p0748 N80-31253		p0761 180-44241
MILLER, L. B.		HOINE, B.	
Aerospace nickel-cadmium/nickel-hydro	odem electrode	The effect of direct and diffuse radi	
process facility	p0769 A80-48396	thermal performance of flat-plate s	
HILLER, M. W.	po 703 ACO-40330	HOLCHANOVA, V. P.	p0620 A80-48793
Electrical power system for the SBS	communication	Investigation of the characteristics	of
satellite		electrochemical coatings for solar-	
	p0617 A80-48309	collectors	
MILLER, E. E.		•	p0611 A80-47164
Optimization studies of lithium/iron	sulfide cells	MOLIBI, A. B.	
for electric vehicle applications	-0762 100 00400	Design of land-based, foam OTEC plant	s for
You approach to allogated anymout go	P0763 A80-48190	bottoming cycles	
Hew approach to electrode current con Lial/iron sulfide cells	llastian fam	f conn 300634 433	-0202 202 20242
	llection for	[CONF-790631-17]	p0742 B80-28913
		MOLISHEVER, B.	•
•	llection for p0763 A80-48191	MOLISHEVER, B. Development of solar driven absorption	•
MILLIMAN, L. D.	p0763 A80-48191	MOLISHEVER, E.  Development of solar driven absorption conditioners and heat pumps	n air
•	p0763 A80-48191	MOLISHEVER, B. Development of solar driven absorption	•
MILLINAE, L. D. Solar thermorhotovoltaic space power MILLIEON, B. P.	p0763 A80-48191 system p0614 A80-48208	BOLISHEVER, B. Development of solar driven absorption conditioners and heat pumps [LBL-10771]	on air p0642 #80-30925
MILLIAME, L. D. Solar thermophotovoltaic space power MILLIBON, B. P. Feasibility study: Fuel cell cogene	p0763 A80-48191 system p0614 A80-48208 ration in a	BOLISHEVEE, B.  Development of solar driven absorption conditioners and heat pumps [LBL-10771] BOLLE, JP. Biomass gasification processes	n air
MILLIAMS, L. D. Solar thermophotovoltaic space power MILLIBON, B. P. Peasibility study: Fuel cell cogene water pollution control facility,	p0763 A80-48191 system p0614 A80-48208 ration in a volume 1	MOLISHEVEE, B.  Development of solar driven absorption conditioners and heat pumps [IBL-10771]  MOLLE, JP.  Biomass gasification processes  MOLLY, J.	p0642 #80-30925
MILLIMAB, L. D. Solar thermophotovoltaic space power MILLIBOH, B. P. Peasibility study: Fuel cell cogene water pollution control facility, [DOB/ET-12431/T1-VOL-1]	p0763 A80-48191 system p0614 A80-48208 ration in a	BOLISHEVEE, R. Development of solar driven absorption conditioners and heat pumps [LBL-10771] BOLLE, JP. Biomass gasification processes BOLLY, J. Composite rotor blades for large wind	p0642 #80-30925
MILLIMAB, L. D. Solar thermorphotovoltaic space power  MILLIBOB, H. P. Feasibility study: Fuel cell cogener water pollution control facility, [DOB/ET-12431/T1-VOL-1]  MILLBER, A. B.	p0763 A80-48191  system p0614 A80-48208  ration in a volume 1 p0749 880-31522	MOLISHEVEE, B.  Development of solar driven absorption conditioners and heat pumps [LBL-10771]  MOLLE, JP.  Biomass gasification processes  MOLLY, J.  Composite rotor blades for large wind installations	n air p0642 #80-30925 p0682 #80-49978 energy
MILLIMAB, L. D. Solar thermophotovoltaic space power  MILLIBON, B. P. Feasibility study: Puel cell cogene water pollution control facility, [DOB/ET-12431/T1-VOL-1]  MILLBER, A. B. Besidential photovoltaic flywheel st	p0763 A80-48191  system p0614 A80-48208  ration in a volume 1 p0749 880-31522	MOLISHEVEE, R.  Development of solar driven absorption conditioners and heat pumps [LBL-10771]  MOLLE, JP.  Biomass gasification processes  HOLLY, J.  Composite rotor blades for large wind installations [MASA-TM-75822]	p0642 #80-30925
MILLIMAB, L. D. Solar thermorphotovoltaic space power  MILLIBOB, H. P. Feasibility study: Fuel cell cogener water pollution control facility, [DOB/ET-12431/T1-VOL-1]  MILLBER, A. B.	p0763 A80-48191 system p0614 A80-48208 ration in a volume 1 p0749 E80-31522 orage system	HOLISHEVEE, R. Development of solar driven absorption conditioners and heat pumps [LBL-10771] HOLLE, JP. Biomass gasification processes HOLLY, J. Composite rotor blades for large wind installations [HASA-TM-75822] HOLYBROU, H. S.	n air p0642 #80-30925 p0682 #80-49978 energy
MILLIMAB, L. D. Solar thermophotovoltaic space power  MILLIBON, B. P. Feasibility study: Puel cell cogene water pollution control facility, [DOB/ET-12431/T1-VOL-1]  MILLBER, A. B. Besidential photovoltaic flywheel st	p0763 A80-48191  system p0614 A80-48208  ration in a volume 1 p0749 B80-31522  orage system p0768 A80-48377	MOLISHEVEE, B. Development of solar driven absorption conditioners and heat pumps [LBL-10771] MOLLE, JP. Biomass gasification processes  MOLLY, J. Composite rotor blades for large wind installations [BASA-TH-75822] MOLYHRAUL, M. S. Liquid fuels production from biomass	n air p0642 #80-30925 p0682 #80-49978 energy
MILLIMAB, L. D. Solar thermophotovoltaic space power  MILLIBON, B. P.  Feasibility study: Fuel cell cogener water pollution control facility, [DOB/ET-12431/T1-VOL-1]  MILLBER, A. B.  Besidential photovoltaic flywheel steperformance and cost  System design, tests results, and eccanalysis of a flywheel energy store	p0763 A80-48191 system p0614 A80-48208 ration in a volume 1 p0749 880-31922 orage system p0768 A80-48377 onomic age and	HOLISHEVEE, R. Development of solar driven absorption conditioners and heat pumps [LBL-10771] HOLLE, JP. Biomass gasification processes HOLLY, J. Composite rotor blades for large wind installations [HASA-TM-75822] HOLYBROU, H. S.	p0642 #80-30925 p0682 #80-49978 energy p0749 #80-31881
MILLIMBE, L. D. Solar thermophotovoltaic space power  MILLIBOB, B. P. Feasibility study: Fuel cell cogene: water pollution control facility, [DOB/BT-12431/T1-VOL-1]  MILLIBER, A. B. Besidential photovoltaic flywheel st- performance and cost  System design, tests results, and ec- analysis of a flywheel energy stor- conversion system for photovoltaic	p0763 A80-48191  system p0614 A80-48208  ration in a volume 1 p0749 B80-31922  orage system p0768 A80-48377 onomic age and applications	HOLISHEVEE, B. Development of solar driven absorption conditioners and heat pumps [LBL-10771] HOLLE, JP. Biomass gasification processes  HOLLY, J. Composite rotor blades for large wind installations [BASA-TH-75822] HOLYHEMOU, B. S. Liquid fuels production from biomass [COO-4388-10] HOLZ, F. J. Experimental and theoretical studies	p0642 #80-30925 p0642 #80-49978 energy p0749 #80-31881 p0708 #80-32545
MILLIMAB, L. D. Solar thermophotovoltaic space power  MILLIBON, B. P. Feasibility study: Fuel cell cogene water pollution control facility, [DOB/RT-12431/T1-VOL-1]  MILLBER, A. B. Besidential photovoltaic flywheel st- performance and cost  System design, tests results, and ec- analysis of a flywheel energy stor- conversion system for photovoltaic [COO-4094-70]	p0763 A80-48191  system p0614 A80-48208  ration in a volume 1 p0749 #80-31522  orage system  p0768 A80-48377  onomic age and applications p0746 #80-30928	HOLISHEVEE, R. Development of solar driven absorption conditioners and heat pumps [LBL-10771] HOLLE, JP. Biomass gasification processes  HOLLY, J. Composite rotor blades for large wind installations [HASA-TM-75822] HOLYBERDY, H. S. Liquid fuels production from biomass [COO-4388-10] HOLE, P. J.	p0642 N80-30925 p0682 A80-49978 energy p0749 B80-31881 p0708 N80-32545 of thermal
MILLIMBE, L. D. Solar thermophotovoltaic space power  MILLIBOB, B. P. Feasibility study: Fuel cell cogene: water pollution control facility, [DOB/BT-12431/T1-VOL-1]  MILLIBER, A. B. Besidential photovoltaic flywheel st- performance and cost  System design, tests results, and ec- analysis of a flywheel energy stor- conversion system for photovoltaic	p0763 A80-48191  system p0614 A80-48208  ration in a volume 1 p0749 #80-31522  orage system  p0768 A80-48377  onomic age and applications p0746 #80-30928	HOLISHEVEE, B. Development of solar driven absorption conditioners and heat pumps [LBL-10771] HOLLE, JP. Biomass gasification processes  HOLLY, J. Composite rotor blades for large wind installations [BASA-TH-75822] HOLYHEMOU, B. S. Liquid fuels production from biomass [COO-4388-10] HOLZ, F. J. Experimental and theoretical studies	p0642 #80-30925 p0642 #80-49978 energy p0749 #80-31881 p0708 #80-32545

HOMENTHY, A. H.	•	DOE view of solar power commercializa	tion and
Aviation fuels outlook .	84 N80-29304	applications	p0629 A80-528
MOMINI, G. A.		MOSER, R. L.	pec23 200 320
A study of the gaseous and particulate po in the environment of a thermal power p		470-kw photovoltaic power system for villages	Saudi Arabia
project area	. ,		p0616 A80-482
MONTER, W. R.  Development of a lithium-water-air primar	v hatterv	MOSIER, S. A. Advanced combustion systems for stati turbine engines. Volume 2: Bench	
POTE	8 A80-48372	evaluation [PB80-175607]	p0744 880-299
Comparative analysis of net energy balance Satellite Power Systems (SPS) and other		MOSEA, P. J., JE. Photovoltaic module electrical termin	_
systems		requirement study	-
MONCRINF, C. Y.	32 N80-30916	HOSS, D. P.	p0644 N80-318
The economic feasibility of passive solar heating systems	space	Requirements for materials for land w	ehicle gas
p062	27 A80-52832		p0743 N80-293
HOMEOWSKI, J. E. The influence of grain size and dopant	:	HOSTOPIZADES, C.  The use of refuse heat assisted by he	at transforme
concentration on the electrical propert	ies of /	•	p0686 A80-514
polycrystalline silicon films	00 A80-46696	Thin films of InP for photovoltaic er	oras consorci
MONTGONERIE, B.			p0642 N80-309
Safety of wind energy conversion systems	(WECS):	HOULTON, D. S.	
Preliminary study [PFA-BU-2126]  POST	12 N80-28933	Hydration of 'spent' limestone and do enhance sulfation in fluidized-bed	
EUSIICELU, U. A.		•	p0672 A80-481
Energy principle with global invariants in toroidal plasmas	or	MOURIKIS, A.  Synthesis of four bar linkages for so	lar tracking
po71	17 180-43973		p0624 A80~516
MOON, R. L. Operation of multi-bandgap concentrator of		MOUSSAVI, S. J. Combustion of drops and sprays of no.	
a spectrum splitting filter p066 BOORE, D.	04 A80-46740	and its emulsions with water and me Volume 1: Experimental [PB80-178213]	р0698 180-304
Ultrasonic characterization of coal lique products	efaction	MUBAYI, V.  Costing methodologies for energy syst	-
[DOB/PC-10346/1] p070	02 N80-31503	[BNL-27603]	p0778 N80-329
Applications of DOE-1 to passive solar he		Stack gas reheat evaluation [PB80-196850]	-AEG2 NGA-330
commercial buildings - Preliminary rest p06: Assessment of environmental control techn	26 A80-52831	HUBLIBB, B. G.  Efficiency of coal use, electricity f	
for energy storage systems, 1979		synfuels for ICEs [SAB PAPER 800109]	
	88 N80-32973	[SAE PAPER 800109]	p0680 A80-497
MOORE, P. W. Biomass energy production. Citations fro	m the	*Biberonnage* makes an electric car p	ractical with
International Aerospace Abstracts data	base .	existing batteries	
[PB80-810807] p07'		[SAE PAPER 800204] BURLLEB, V. C.	p0773 A80-497
Bending behavior of lapped plastic BHV ca [BNL-27331] p076	ables	Nickel-cadmium batteries for the Modu Subsystem	lar Power
BORGAN, W.			p0769 A80-483
Results from study of potential early commended the management of		Nickel-hydrogen battery integration s Hultimission Hodular Spacecraft	p0770 A80-484
MORI, T.	,	MURLLER, W. K.	
Integrated system for solid waste dispose energy recovery and volumetric reduction pyrolysis furnace		Department of Housing and Orban Devel hot water initiative: Centralized of technical tasks and system evalu	coordination
POGE MORISHITA, T.	32 A80-49982	[ PB80-189244]. HULDOON, W. J.	p0656 N80-329
Nonlinear coupling of the slow wave structure the lower-hybrid waves near the plasma		Computer simulation of solar panel vo	oltage
p07:	20 A80-45291	•	p0612 A80-481
MORRIS, J. P. Optimal thermionic energy conversion with	i	Bending behavior of lapped plastic 28	W cables
established electrodes for high-temperatopping and process heating	iture	[BNL-27331] BULLER, J. C.	p0760 N80-327
[NASA-TH-81555] p075	54 N80-33221	Ion implanted solar cells from EPG si	licon ribbons. p0601 A80-467
Solar hot air balloons	28 A80-52E41	Improvement of phosphorus diffused si cells by laser treatment	
MORRISON, W. W.			P0606 A80-467
The long-term effects of trace elements, e	mitted by	MOLLIB, J. P.	
energy conversion of lignite coal [PB80-168867] p057	18 N80-28958	Progress in space power technology	p0722 A80-481
The long-term effects of trace elements of	mitted by	BASA technology program overview	
energy conversion of lignite coal. Vol Technical appendices	_	HURATA, K.	p0782 N80-334
[PB80-168875] p051	79 N80-28960	Performance of the recently developed for the BTS-III batteries	ar-ca cerra
Photovoltaics commercialization readiness	s assessment 07 A80-46772		p0769 A80-483
		,	

p0677 A80-48402

MORIN, P.	BANGIA, V. K.
Environmental assessment report: Wellman-Galusha low-Btu gasification systems	Materials for coal conversion and use. Volume 2: Materials of construction for coal conversion
[PB80-190796] p0589 N80-32995	systems. Part 1: Coal gasification. Part 2:
MURPHY, D. P. Tidal energy in the Bay of Pundy	Coal liquefaction [FE-2468-59-VOL-2-PT-1/2] p0705 N80-3164
p0688 A80~53680	Direct electrochemical generation of electricity
Condenser designs for binary power cycles	from coal
p0723 A80-48221	[SAH-0115-105-1] p0752:N80-3286 HATSCH, B.
Solar energy conversion through biophotolysis [SAN-0034-239-1-T2] p0666 N80-31927	Preparation and analysis of Cu20 thin-film solar cells
MURTHA, M. J. Processes to increase utilization of power solid	p0607 A80-4678
vastes	Recycling of effluents and organic residues into
[ISM-245] p0702 N80-30929	methane by anaerobic digestion - New perspectives p0683·180-4999
Near term commercialization of MHD power generation using coal/oil fuel	HAVISE, P. H., JR. Collector sealants and breathing
p0724 A80-48225	[DOB/CS-15362/1] p0650 N80-3252
AURTY, B. V. B. A study of the gaseous and particulate pollutants	BECKYPAROW, C. M.  Potential of spark ignition engine, effect of
in the environment of a thermal rower plant project area	vehicle design variables on top speed, performance, and fuel economy
p0570 A80-46150	[PB80-191836] p0586 N80-3273
Composite rotor blades for large wind energy	On the effects of boron and phosphorus primary
installations [NASA-TM-75822] p0749 N80-31881	<pre>impurities in p-type silicon material for solar cells</pre>
MUSSOLMAN, B. L. Simulation and a preliminary comparison of passive	p0606 A80-4675
solar heating systems.	Solaroil project. Phase 1: Preliminary design
[ASHE PAPEE 80-HT-17] p0611 A80-48008	report [GA-A-15823] p0633 N80-2950
<pre>Methods of improving limestone utilization in fluidized-bed combustion</pre>	FRILL, J. H. Fluid selection for a 100 MW/e/ line focus solar
p0672 A80-48170 Hydration of 'spent' limestone and dolomite to	central power station p0630 A80-5357
enhance sulfation in fluidized-bed combustion	BEJAT, Z.
p0672 180-48172	Energy recovery from solid waste for city of Tehran p0681 A80-4994
, · · · NI	NDICAN D B
N	BELSON, E. T. Research and evaluation of biomass
HABOR, M. R.	Research and evaluation of biomass resources/conversion/utilization systems
	Research and evaluation of biomass
HABOR, M. R. Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545 HACHMAR, J. P.	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOB/ET-20611/11] p0700 N80-3055
HABOR, M. R. Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  HACHMAN, J. P. Automotive storage of hydrogen using modified magnesium hydrides	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOR/ET-20611/11] p0700 N80-3055 BENECEK, J. J. Energy storage as heat-of-fusion in containerized
NABOR, M. R. Liquid fuels production from biomass [COC-4388-10] PACHMAN, J. P. Automotive storage of hydrogen using modified	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOB/ET-20611/11] p0700 N80-3055
HABOR, M. R. Liquid fuels production from biomass [COC-4388-10]  HACHAB, J. P. Automotive storage of hydrogen using modified magnesium hydrides [SAM-1167-1]  HADOLSKI, T. P. Photovoltaic applications definition and	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOR/ET-20611/11] p0700 N80-3055  BENECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  BEPHEN, R. A.
NABOR, M. B.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHMAN, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 N80-3055  BENECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  BEPREW, R. A. Theory and design of an Annual Cycle Energy System (ACES) for residences
HABOR, M. R.  Liquid fuels production from biomass  [COC-4388-10] p0708 N80-32545  HACHAN, J. P.  Automotive storage of hydrogen using modified  magnesium hydrides  [SAN-1167-1] p0666 N80-31650  HADOLSKI, T. P.  Photovoltaic applications definition and  photovoltaic system definition study in the	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOR/ET-20611/11] p0700 N80-3055  BENECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  BEPBER, R. A. Theory and design of an Annual Cycle Energy System
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHMAN, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition and photovoltaic system definition study in the	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOB/ET-20611/11] p0700 N80-3055  WHHECHK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  HEPHEW, R. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORNL/CON-43] p0587 N80-3290  HEWBY, K. Development of a bipolar Zn/Br2 battery
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHAMB, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 N80-3055  BENECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  BEPHEW, E. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 B80-3290  BEWEY, K. Development of a bipolar Zn/Br2 battery p0767 A80-4836
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHMA, J. P.  Automotive storage of hydrogen using modified magnesium hydrides [SAM-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAMD-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAMD-79-7018/3] p0652 N80-32891  BAGANURA, T.  Nan-made molecular assemblies for energy	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOS/ET-20611/11] p0700 N80-3055  BENECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  BEPHEN, E. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [OBNL/CON-43] p0587 N80-3290  BENEL, E. Development of a bipolar Zn/Br2 battery p0767 A80-4836  BENELL, T. Key questions in the application of salt-stratified solar ponds
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHAH, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition and photovoltaic system definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  BAGANURA, T.	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 N80-3055  WHHECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  HEPHEW, R. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 N80-3290  HEWELL, K. Development of a bipolar Zn/Br2 battery p0767 A80-4836  HEWELL, T. Key questions in the application of
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHMA, J. P.  Automotive storage of hydrogen using modified magnesium hydrides [SAM-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAMD-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAMD-79-7018/3] p0652 N80-32891  BAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOSET-20611/11] p0700 M80-3055  BERNECKK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 M80-3286  BEPHEW, E. A. Theory and design of an Annual Cycle Energy System (ACSS) for residences [ORNL/CON-43] p0587 M80-3290  BEBUIL, E. Development of a bipolar Zn/Br2 battery p0767 A80-4836  BEBUIL, T. Key questions in the application of salt-stratified solar ponds  BEBUAN, J. O. H. The hydropyrolysis of coal to BIX
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHAH, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  BAGAMURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  BAGATA, S.  Development of a high temperature solid electrolyte fuel cell	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 880-3055  BENECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 880-3286  BEPHEN, E. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 880-3290  BENELL, T. Key questions in the application of salt-stratified solar ponds  BENELL, T. The hydropyrolysis of coal to BTX  BENHAN, V. G.
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHANE, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  NAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  NAGATA, S.  Development of a high temperature solid electrolyte fuel cell p0726 A80-48281	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOS/ET-20611/11] p0700 N80-3055  HENECEK, J. J.  Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  HEPHEN, R. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORMI/CON-43] p0587 H80-3290  HENBY, K. Development of a bipolar Zn/Br2 battery p0767 A80-4836  HENELL, T.  Key questions in the application of salt-stratified solar ponds  P0617 A80-4836  HENBAN, J. O. H. The hydropyrolysis of coal to BTX
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHAMB, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  MAGHURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  NAGATA, S.  Development of a high temperature solid electrolyte fuel cell  P0726 A80-48281	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 880-3055  WHHECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 880-3286  HEPHEW, R. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 880-3290  HEWELL, T. Key questions in the application of salt-stratified solar ponds  HEWHAN, J. O. H. The hydropyrolysis of coal to BTX  HEWHAN, V. G. Large-scale electrical energy storage p0761 A80-4424  BEWSOB, D.
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHAMB, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  NAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  NAGATA, S.  Development of a high temperature solid electrolyte fuel cell  P0726 A80-48281  NAGEL, G.  Progress in the field of terrestrial solar generators	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOS/ET-20611/11] p0700 N80-3055  REMECER, J. J.  Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank (AD-A087753] p0777 N80-3286  BEPHEN, E. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 E80-3290  BENNY, K. Development of a bipolar Zn/Br2 battery p0767 A80-4836  BENNIL, T.  Key questions in the application of salt-stratified solar ponds  BENNIL, J. O. H. The hydropyrolysis of coal to BTX  BENNIN, V. G. Large-scale electrical energy storage p0761 A80-4424  BENSON, D. Bethodology for the comparative assessment of the Satellite Power System (SPS) and alternative
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHMA, J. P.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  BAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  BAGATA, S. Development of a high temperature solid electrolyte fuel cell p0726 A80-48281  BAGEL, G. Progress in the field of terrestrial solar generators p0602 A80-46713  BAGLE, W. J. Toroidal cell and battery	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 N80-3055  BERNECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  BEPHEW, E. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORNL/CON-43] p0587 N80-3290  BEWEY, K. Development of a bipolar Zn/Br2 battery p0767 A80-4836  HEWELL, T. Key questions in the application of salt-stratified solar ponds  HEWEAB, J. O. H. The hydropyrolysis of coal to BTX  HEWHAB, V. G. Large-scale electrical energy storage  BENSOM, D. Rethodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-3195
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHMAH, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3]  PAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  NAGATA, S.  Development of a high temperature solid electrolyte fuel cell  PO726 A80-48281  NAGEL, G.  Progress in the field of terrestrial solar generators  p0602 A80-46713	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 N80-3055  WHRECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  HEPHEW, R. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 N80-3290  HEWELL, T. Key questions in the application of salt-stratified solar ponds  HEWHAN, J. O. H. The hydropyrolysis of coal to BTI  HEWHAN, V. G. Large-scale electrical energy storage  BEWSON, D. Hethodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  NACHMA, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  BAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  BAGATA, S.  Development of a high temperature solid electrolyte fuel cell p0726 A80-48281  WAGEL, G. Progress in the field of terrestrial solar generators p0602 A80-46713  NAGLE, W. J. Toroidal cell and battery [NASA-CASE-LEW-12918-1] p0780 N80-33857  NAIK, M. S. A study of the gaseous and particulate pollutants	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 N80-3055  BENECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  BEPHEW, E. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORNL/CON-43] p0587 N80-3290  BENETL, T. Key questions in the application of salt-stratified solar ponds  HEWHAH, J. O. H. The hydropyrolysis of coal to BTX  HEWHAH, V. G. Large-scale electrical energy storage  BENSOM, D. Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-3195  BENSOM, D. E. Preliminary comparative assessment of land use for the Satellite Power System (SPS) and alternative
NABOR, M. R.  Liquid fuels production from biomass [COO-4388-10] p0708 N80-32545  ACCHAMB, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  BAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  HAGAIA, S.  Development of a high temperature solid electrolyte fuel cell p0726 A80-48281  WAGEL, G. Progress in the field of terrestrial solar generators p0602 A80-46713  WAGEL, W. J. Toroidal cell and battery [NASA-CASE-LEW-12918-1] p0780 N80-33857  BAIK, M. S.  A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 880-3055  WHENCEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 880-3286  HEPHEW, R. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 880-3290  HEWELL, T. Key questions in the application of salt-stratified solar ponds  HEWHAN, J. O. H. The hydropyrolysis of coal to BTX  HEWHAN, V. G. Large-scale electrical energy storage p0761 A80-4836  HEWSOM, D. Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 880-3195  BENSOM, D. E. Preliminary comparative assessment of land use for the Satellite Power System (SPS) and alternative electric energy technologies [NASA-CR-163327] p0580 880-2988
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  ACCHANE, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0596 N80-32870  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  MAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  MAGATA, S.  Development of a high temperature solid electrolyte fuel cell p0726 A80-48281  MAGEL, G. Progress in the field of terrestrial solar generators p0602 A80-46713  NAGLE, N. J.  Toroidal cell and battery [NASA-CASE-LEW-12918-1] p0780 N80-33857  NAIK, N. S. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 N80-3055  BENECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  HEPREW, R. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 N80-3290  HEWBY, K. Development of a bipolar Zn/Br2 battery p0767 A80-4836  HEWBALL, T. Key questions in the application of salt-stratified solar ponds  HEWBALL, T. The hydropyrolysis of coal to BTX  P0688 A80-5317  HEWMAN, V. G. Large-scale electrical energy storage  BEWSOM, D. Rethodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-3195  BEWSOM, D. E. Preliminary comparative assessment of land use for the Satellite Power System (SPS) and alternative electric energy technologies [NASA-CR-163327] p0580 N80-2988  Study of gelled LNG
NABOR, M. R.  Liquid fuels production from biomass [COO-4388-10] p0708 N80-32545  ACCHAMB, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOI-2] p0586 N80-32870  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  MAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  MAGATA, S.  Development of a high temperature solid electrolyte fuel cell p0726 A80-48281  MAGEL, G. Progress in the field of terrestrial solar generators p0602 A80-46713  MAGEL, W. J.  Toroidal cell and battery [NASA-CASE-LEW-12918-1] p0780 N80-33857  MAIK, M. S.  A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area p0570 A80-46150  MANDI, S. P. Peat char gasification - Laboratory and PDU-scale	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 880-3055  BERECEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 880-3286  BEPHEN, E. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 880-3290  BEWELL, T. Key questions in the application of salt-stratified solar ponds  BEWHAN, J. O. H. The hydropyrolysis of coal to BTX  BEWHAN, V. G. Large-scale electrical energy storage  BEWSON, D. Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049] p0750 880-3195  BEWSON, D. E. Preliminary comparative assessment of land use for the Satellite Power System (SPS) and alternative electric energy technologies [NASA-CR-163327] p0580 880-2988  Study of gelled LNG [DOE/EV-02057/T2] p0695 880-2950
NABOR, M. R.  Liquid fuels production from biomass [COC-4388-10] p0708 N80-32545  ACCHANE, J. F.  Automotive storage of hydrogen using modified magnesium hydrides [SAN-1167-1] p0666 N80-31650  NADOLSKI, T. P.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0596 N80-32870  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 N80-32891  MAGANURA, T.  Man-made molecular assemblies for energy conversion from light into chemical potentials p0661 A80-46271  MAGATA, S.  Development of a high temperature solid electrolyte fuel cell p0726 A80-48281  MAGEL, G. Progress in the field of terrestrial solar generators p0602 A80-46713  NAGLE, N. J.  Toroidal cell and battery [NASA-CASE-LEW-12918-1] p0780 N80-33857  NAIK, N. S. A study of the gaseous and particulate pollutants in the environment of a thermal power plant project area	Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model) [DOE/ET-20611/11] p0700 N80-3055  WHENEEK, J. J. Energy storage as heat-of-fusion in containerized salts. Report on energy storage boiler tank [AD-A087753] p0777 N80-3286  HEPHEN, R. A. Theory and design of an Annual Cycle Energy System (ACES) for residences [ORBL/CON-43] p0587 H80-3290  HENBY, K. Development of a bipolar Zn/Br2 battery p0767 A80-4836  HENBELL, T. Key questions in the application of salt-stratified solar ponds  HENBAN, J. O. H. The hydropyrolysis of coal to BTX  HENBAN, V. G. Large-scale electrical energy storage  BENSOM, D. Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [NASA-CR-163049]  BENSOM, D. E. Freliminary comparative assessment of land use for the Satellite Power System (SPS) and alternative electric energy technologies [NASA-CR-163327]  BENTON, B. A. Study of gelled LNG

MGUYER, B. B. BOWAL. D. E. A proposed slotted mask for direct deposition of metal contact pattern on MIS solar cells p0595 A80-45119 EICHOLLS, R. L.
Heat loss and storage functions for a thermal well p0596 A80-45318 BICHOLS, D. G.
Pollutants from synthetic fuels production: Coal gasification screening test results D0707 N80-31986 PB80-1827691 NICHOLS, R. J. Study of hydrogen-powered versus battery-powered automobiles [ATR-79 (7759) -1-VOL-1] p0665 N80-31271 MICKOLS, B. C.
Development of molten carbonate fuel cell power plant technology [DOB/ET-15440/1] p0750 N80~31938 MICOLNIS, L. The development of thermal energy storage systems exploiting solid-solid phase transitions p0774 A80-50970 BICOLAS, B. O. Generalization of the two-dimensional optical analysis of cylindrical concentrators p0599 A80-46566 EICOLAYEFF, V.
Solaroil project. Phase 1: Preliminary design report [GA-A-15823] p0633 N80-29505 SIRDAWACEI, J. M.

Ocean wave power available to submerged energy devices of finite dimensions .p0689 A80-53681 Preparation and analysis of Cu20 thin-film solar cel 1s p0607 A80-46781 The feasibility of pellet re-fuelling of a fusion reactor D07-19 A80-44661 MIBSS, R. C. High temperature heat pump applications -Commercial, industrial, and with alternative energy sources p0670 A80-47590 BIGGENANS, R. E.
The 1980 technology status of the Dynamic Isotope Power System p0725 A80-48255 Bxperimental optimization of the efficiency of n/+/-p-p/+/ and p/+/-n-n/+/ silicon solar cells p0601 A80-46706 BIRGAIAH A horizontal axis sail windmill for use in irrigation [NAL-TN-54] p0743 h
HISRIDA, N.

Qualitative and quantitative assessment of reaction models of coal hydrogenation p0743 N80-29844 p0679 A80-49629 HISRIJINA, T.
Ban-made molecular assemblies for energy
conversion from light into chemical potentials
n0661 A80-44 p0661 A80-46271 HOACE, R. Fuel gas from used tyres by means of the Babcock-Rohrbach process p0685 A80-50036 Photovoltaic institutional issues study

p0584 N80-31950

D0675 A80-48323

P0769 A80-48400

[SAND-79-7054]

liquid tuels

control parameters

BORMAN, J. B.

BORTE, H. B.

HOLLN, E. J.
Potential for biological conversion of biomass to

Hydrogen production by the GA sulfur-iodine process [GA-A-15777-REV] p0666 880-31651

Linear constraints aid selection of battery charge

Summary of guidelines for siting wind turbine generators relative to small-scale, two-dimensional terrain features [BLO-2443-77/1] p0647 N80-31930 HORIK, A. J. Photoelectrochemistry with p-Si electrodes -Effects of inversion Energy savings in a rotary kiln in the production of cement through the addition of domestic waste and sewage sludge p0574 A80-49958 BUSINOVICE, G. S. Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in large tokamaks p0738 A80-51038 Development status of the General Electric solid polymer electrolyte water electrolysis technology p0662 180-48413 MIBS. B. J. Recycling of effluents and organic residues into methane by anaerobic digestion - New perspectives p0683 180-49995 O OANCEA, C. The optimal interconnection of solar collectors in air heating systems with large collector surfaces
p0620 A80-48794 OBENSCHAIN, A. P. Design and performance of the International Sun-Earth Explorer power systems p0765 A80-48307 The potential and economics of wind energy investigation commissioned by the International Energy Agency for the Federal Republic of Germany p0689 A80-54077 OBEROI, H. S.
Residential solar heating and cooling using
evacuated tube solar collectors: CSU Solar. House 3, executive summary [COO-2858-24] p0647 N80-31941 OBBIEN, 6.
Design of a photovoltaic system for a southwest all-electric residence [SAND-79-7056] p0637 N80-29876 OBRIES, J. P.
Gas turbines for automotive use p0736 A80-50351 OCHS, T. L. Operational experience with a saturated borax solar pond p0617 A80-48365 CDAWABA, Y. Biogasification of municipal waste p0683 A80-49997 ORTTINGER, P. B. Electric energy production by particle thermionic-thermoelectric power generators OFFERHARIZ, P. O'D. Engineering prototype studies on the CaCl2-CH3OH chemical heat pump for solar air conditioning, heating, and storage p0616 A80-48289 OFVERHOLB, R. Beporting format for thermal performance of solar heating and cooling systems in buildings [PB80-175375] p0634 p0634 N80-29537 OGATA, I.
A new rechargeable high voltage low temperature molten salt cell p0764 A80-48237 Transport code simulations of lower hybrid heating in tokamaks p0719 A80-44664 OGEADY, W. E.
Fuel cell applied research: Electrocatalysis and materials [BNL-510531 p0742 N80-28920

p0717 A80-44231

Fuel cell applied research: Electi	rocatalysis and	OFFAL, D. L.	
materials		An energy and cost analysis of resid	lential heat
[BWL-51072]	p0744 #80-29885	pumps in northern climates	
OGURISOV, A. P.	ine plant	AMERICA I D	p0571 A80-4842
A 150 MW power generating gas turbi	p0719 A80-44773	OFFPROY, J. B. High-efficiency concentration/multi-	-colar-coll
CHIBO, T.	ports E00-44113	system for orbital power generation	
Conceptual design of RST: An rf-da	civen.	Direct for orbital poster describer.	p0614 180-4820
steady-state Tokamak		OBO, M.	•
[ EPRI-AP-1351 ]	p0751 N80-32233	Parametric decay into ion cyclotron	waves and
OHLSSON, O. O.		drift waves in multi-ion species p	
The role of refuse derived fuel /RI	FD/ as an		p0735 A80-4907
alternative energy source for dis	strict heating	Parametric excitation of ion quasi-m	
and boset denergeton	p0675_A80-48331	pump near the ion cyclotron freque	р0736 <u>д</u> 80-4907
OHO, T.	P***** 200 40331	OPENSHAN, P.	P0130 200 4301
Devolopment of a high temperature of	solid	Solaroil project. Phase 1: Prelimi	nary design
electrolyte fuel cell		report	·
	p0726 A80-48281	[GA-A-15823]	p0633 N80-2950
OKREPR, D. R.		OPJORDEN, R.	
Hydrogen production by the GA sulfu	ir-iodine process	Thin, high efficiency silicon solar	cells
[GA-A-15777-REV] OKUBO, D.	D0000 N80-31021	ADPID A T	p0658 N80-3388
Reactively sputtered thin film cu/s	snb #/S/CAS	ORBAR, D. J.  Refining and upgrading of synfuels f	row coal and
photovoltaic devices		oil shales by advanced catalytic p	
	p0637 #80-29875	[PE-2315-48]	p0703 H80-3162
OKUHUBA, B.	•	ORGILL, M. M.	• '
Biogasification of municipal waste		Siting handbook for small wind energ	y conversion
	p0683 A80-49997	systems	
OKUNO, S.		[PNL-2521-RBV-1]	p0747 180-3094
The advantages of using an incinera		ORIEGA, J. E. B.	-h1 "
system to control the emission of and steam generation in refuse in		Performance of storage walls with hi conductive covering plates and con	
404 000 Junior 10 10 100 100 100 100 100 100 100 100	p0574 A80-49961	[ASME PAPER 80-HT-18]	p0762 A80-4800
OLAPSEN, A. G.		Performance of storage walls with hi	
Solar energy conversion through bio	photolysis	conductive covering plates and con	
[SAH-0034-239-1-T2]	p0666 N80-31927	[ SERI/TP-721-574]	p0779 N80-3294
OLCESE, G. L.		Computer modeling of thermal storage	
Hydrogen storage in a beryllium sub	stituted TiPe		p0779 N80-3294
compound	p0661 A80-45060	OSTER, J. B., JR. Operation and maintenance cost data	for
OLEHDER, H.	P0001 N80-45000	residential photovoltaic modules/p	
Puel cell applied research: Electr	ocatalysis and	[NASA-CR-163585]	p0650 N80-3285
materiale .		OTAWA, T.	
[BNL-51053]	p0742 N80-28920	Wind energy planning - Development a	
Puel cell applied research: Electr	cocatalysis and	of a site selection method for win	d energy
. materials	-070" "70 2005	conversion systems /WECS/	0740 -00 000
[BNI-51072] OLEXSEL, B.	p0744 N80-29885	OFIC D D	p0719 A80-4467
Economic and technical evaluation of	of the Ames.	OTIS, D. R. Wind energy capacity of a single air	foil with
Iowa solid waste recovery system		vertical axis on a circular track	
- · · · · · · · · · · · · · · · · · · ·	P0683 A80-50005		p0673 A80-4827
OLEISEY, R. A.	_	OTIS, J. L.	<del>-</del>
Municipal solid waste as an industr		Pilot study to select candidates for	
m	p0670 A80-47589	Conservation research for the chem	
Environmental impact of conversion	or teruse to	[DOS/TIC-11114] OTOHA, S.	p0584 N80-3194
energy	p0574 A80-49954	Application of the energy concept to	a resource
OLIVBET, W. P.		recovery system	d reporte
Refinery energy profile [ORO-5262-5-SUPPL]	·		p0574 A80-4993
[ORO-5262-5-SUPPL]	p0577 N80-28857	OTOOLE, R. P.	•
OLMER, L. J.		Intergenerational equity and conserv	ation
Puel cell applied research: Electr	ocatalysis and	[ NASA-CR-163434 ]	p0580 N80-2986
<pre>materials [BNI-51053]</pre>	p0742 N80-28920	OTTO, B. C. Calcium direct displication secondary sel	le
Puel cell applied research: Electr		Calcium/iron disulfide secondary cel	₽0764 A80-4823
materials		OTRINGER, B. M.	P0.04 Z00 4025
[BNL-51072]	p0744 N80-29885	Test data analysis and application o	f nickel
OLSEB, L. C.		hydrogen cells ,	
Investigation of low-cost solar cel		5	p0771 A80-4844
[DOB/ET-23006/3]	p0653 N80-32915	OUCHI, E.	• • •
OLSBN, R. B. Demonstration of heat to electrical	eneray.	Average chemical structure of mild h	yarogenolysis
conversion with a ferroelectric m		products of coals	p0679 180-4962
CONTRIBION TIEM & TERIORIECTIC M	p0729 A80-48386	OACHIMHIROA" b" y"	PAOL'S WOO-4307
OLSOE, J. E.		Magnetoplasma compressor with an exp	losion-driven
Effect of operating conditions on p	roduction of	magnetic power generator	
light hydrocarbon gases in slaggi			p0717 A80-4418
coal gasification	-0605	ONRE, W. P.	
[GPETC/RI-80/2]	p0695 N80-29507	Feasibility of a peat biogasificatio	
OLSON, R. R. The Sphercrak fusion reactor		OPERS, W. L.	p0669 A80-4619
THE PAREFORMY TROUGH TEMPORAL	p0733 A80-48495	Review of mini-OTEC performance	
OLSSON, W. J.			p0727 180-4834
JT9D-7A /SP/ jet engine performance	deterioration	OVERS, W. B.	
trends		Closed cycle MHD power plant and ret	rofit
crenus	D0569 A80-04230	ontimization application	

OYAHOTO, T. Development of a methane fermentation process for organic wastes P0679 A80-49545 OSBOYA, E. Performance and applications potential of a turbine-pump with controlled flow rate p0768 A80-48375 PADDISON, P. C.
Use of geothermal energy in the eastern United States P0685 A80-50908 PADRYE, A. V. Department of Housing and Urban Development solar hot water initiative: Centralized coordination of technical tasks and system evaluation p0656 N80-32961 FB80-1892441 PAGAMESSI, J. Liquid products from peat pyrolysis p0677 A80-48385 PAGE, 6. C.
Environmental assessment report: Wellman-Galusha low-Btm gasification systems [PB80-190796] p0589 N80-32995 PAGEBEOFF, G. K. Factors influencing the release of boron from coal ash materials P0570 A80-45484 PALMER, 8. B.
Cogeneration Technology Alternatives Study (CTAS).
Volume 3: Industrial processes
10749 N80-318 Volume 3: Indust [NASA-CR-159767] p0749 N80-31870 PALAGRRE, D. Wind energy capacity of a single airfoil with vertical axis on a circular track p0673 A80-48274 PALBITER. L A comparison of performance factors for passive solar heating p0627 A80-52837 PALS. U. Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings p0600 A80-46694 PAMPREES, R. C.
Upgraded automotive gas turbine engine design and development program, volume 2 [NASA-CE-159671] p0751 N80-32719 Y. S. Recent coal-oil mixture combustion tests at PRTC [DOE/PETC-TR-80/5] p0706 B80-31658 PABASIUK, B. P. Thermodynamic analysis of the helium cycles of gas turbine nuclear power plants D0721 A80-47080 PANDRY. R. K. Solar energy conversion using CdSe photoelectrochemical cells with low cost substrates p0597 A80-46253 Catalytic combustion of hydrogen in model appliances p0662 A80-48415 PAPPAS. J. B. Hydrogen engine performance analysis project [SAN-1212-T1] p0665 N80-30756 PARISI, A.
On the effects of boron and phosphorus primary impurities in p-type silicon material for solar p0606 A80-46758 PARK, Y. W. Development of a tubular lithium-iron sulfide cell p0763 A80-48192 PARKER, G. H.
Recent progress on the sulfur cycle hybrid hydrogen production process p0663 A80-48460 PARKER. J. Design of a photovoltaic system for a southwest all-electric residence [SAND-79-7056] p0637 N80-29876 PARKER, E. J. Biomass - Future developments 90687 A80-52858

PARKINSON, B. A.
Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides [IS-4724] p0648 N80-31952 PAROUBEK, S. A.
Waste handling Rijnmond - Energy production of a
large-scale waste incineration plant
no681 A80-4 p0681 A80-49963 Experimental and theoretical studies of thermal energy storage in aquifers p0766 A80-48334 PARSLY, L. P. Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program p0677 A80-48428 PARSONS, V. Hicro-level land use impacts of bioconversion [LA-UB-80-1426] p0709 H8 p0709 N80-32562 PABTALE, L. D.

Beactively sputtered thin film cu/sub x/S/CdS
photovoltaic devices

po637 N80-CUCID-185921 D0637 N80-29875 PARUNGO, P. P. Conversion of mitrogen oxide gases to mitrate particles in oil refinery plumes D0572 A80-48534 Investigation of the feasibility of methanol as an automobile fuel D0688 A80-52881 PASICHNII, V. V.
A study of the heat-induced fracture characteristics of materials under intense radiant heating p0609 A80-46815 PASSELERGUE, P. Combined production of electrical energy and heat in municipal refuse incinerators in the greater Paris area p0682 A80-49965 PATERA, R. P.
Irradiance on the receiver of a general optical concentrator p0610 A80-47043 PATTERSON. D. J. Modifications for use of methanol or methanol-gasoline blends in automotive vehicles p0708 N80-32552 [ALO-3682-T1] PAUL, D. B.
Fluidized bed combustion of refuse derived fuels
p0684 A80-5 p0684 A80-50019 PAULSEE, E.
Test data analysis and application of nickel hydrogen cells p0771 A80-48446 PAUWELS, H. Survey of semiconductor combinations for optimum heterojunction thin film solar cells p0605 A80-46753 PATHE, R. C.
Design and operation of fluidised bed industrial boilers and hot gas producers D0672 A80-48202 PRARSON, J.

Tests of a lightweight 200 kW MHD channel and diffuser [AD-A087022] p0751 880-32226 PRAESOE, J. D.
Comparative assessment of five long-run energy projections [ DOE/ELA/CR-0016/02] p0582 N80-30936 PRAESOS, J. 2.
A two-dimensional analysis of flat plate air-heating solar collectors
[ASHE PAPER 80-HT-117] p0612 A80-48038 PRDERSEE, S. D.
The potential in Denmark for substituting natural resources by waste incineration products p0682 A80-49974 PROULLI. L. Effect of laser irradiation on the characteristics of implanted layers for silicon solar cells p0602 A80-46711

	•		
PEPLEY, B.		PETRON, A. G.	
Methanol/ethanol/gasoline blend fue		Energy savings by means of fuel cell	l electrodes in
demonstration with stratified cha	arge 'engine	electro-chemical industries.	
vehicles [PB80-192123]	p0713 #80-33606	[C00-4881-12]	p0745 880-3090
PEL, B. I.	PO 112 NOO-33808	PRITIT, R. B. Oxidation of electrodeposited black	chrose
A quantitative evaluation of close	1-cycle ocean	selective solar absorber films	CHIOME
thermal energy conversion (OTEC)		[SAND-80-1045C]	p0656 N80-3295
central station applications		PRITI, D.	
[R-2595-DOB]	p0749 N80-31885	Proceedings of the Ocean Energy Info	ormation
PELLET, B. J.		Dissemination Workshop	
Catalyst development for coal lique		[SERI/TP-732-600]	p0753 N80-3295
[EPRI-AP-1233]	p0696 #80-29508	PRITI, S.	- 7 1
PELLICASE, J. P.	la budananahad	Open-cycle HHD power conditioning as	1d COULLOT
Optimization studies of materials i amorphous silicon solar cells	In mydrogenated	requirements definition	p0752 N80-3286
dmorphods stricon sorar cerrs	p0602 A80-46717	[EPBI-AP-1345] PFRIFFRR, E.	p0/32 800-3200
Amorphous thin films for solar-cell		Solar cells with concentrating colle	ectors and
[DOB/ET-21074/4]	p0653 N80-32921	integrated heat use system	
PERDERGRASS, J. B.	•	•	p0604 A80-4674
Present and future status of thermo	ochemical cycles	Pristrer, P.	
applied to fusion energy sources		BBIC and capacitance measurements or	ı Cu2S-CdS
DOWNER D D	P0663 A80-48450	solar cells - Stability problems	
PREDSE, D. B.	Cama	Tatanata Cube Cae this file cales	p0603 A80-4672
Social acceptance of energy systems observations on the situation in		Integrated Cu2s-CdS thin film solar	p0606 A80-4677
observations on the situation in	p0572 A80-49025	PHADER, L. G.	P0000 M80-4077
PRESELL, W. T.	P-3.12 Acc 43623	Assessment of hydrogen compressor to	chnology for
Wind characteristics program elemen	it	energy storage and transmission sy	
[PNL-3211]	p0754 N80-33073	[ORO-5598-T1]	p0667 N80-3292
PRESER, S. S.		PHILLIPS, W. P.	•
Research needs for coal gasification	on and coal	Heat exchanger effectiveness for sol	lar collectors
liquefaction	2600 -00 5000-		p0596 A80-4532
DEDCTELY C B	P0688 A80-53274	PHUNG, D. L.	
PERCIVAL, C. D. Planning for electric utility solar	- annliantiona.	Assessment of industrial energy cons	ervation by
The effects on reliability and pr		unit processes [OBAU/IBA-80-4(H)]	p0584 N80-3193
estimates of the variability in a		PHUOC, ET.	P0204 800-2132
[SERI/TP-351-545]	p0587 880-32888	Early assessment of the photovoltaid	3
PERONA, J. J.	•	potentialities of RAD polysilicon	
Simulation of mass transfer process	ses in		p0600 A80-4670
geothermal power cycles with dire	ct contact heat	PICCIPELLI, R. A.	
exchange .		Heat and mass transfer processes dur	ing the
	P0724 A80-48222	pyrolysis of antrim oil shale	0.004 .00 .000
PERRAM, C.		[ASME PAPER 80-HT-123]	p0671 A80-4803
Batteries for solar electricity	p0605 A80-46747	PICKETT, D. P. Establishment of parameters for prod	inction of long
PRESON, A.	P0003 200 40147	life nickel oxide electrodes for r	
Kelp farm and OTEC-1 upwelling pipe	as	cells	
	P0740 A80-53675		p0771 180-4844
PRIELIE, M. I.		PICOLOGLOU, B. P.	-,
Some perspectives on the use of por		U.S./U.S.S.B. joint MHD generator to	sting at the
for the electron-cyclotron plasma	i heating in .	U-25 MHD pilot plant	
large tokamaks	-0730 100-E1030	DIRECT OF M	p0724 A80-4822
PETEREA, J. A.	p0738 A80-51038	PIRRCE, R. M. Advanced combustion systems for state	i
Mean wind forces on parabolic-troug	ih solar	turbine engines. Volume 2: Bench	
collectors	1 50141	evaluation	, 20476
[SAND-80-7023]	p0650,880-32790	[ PB80-175607]	p0744 880-2992
PETERS, U.		Advanced combustion systems for stat	
Potentialities and limitations of f	uture use of	turbine engines. Volume 4: Comb	istor
coal for power generation	1	verification testing, addendum	
Aparacan s	p0685 A80-50817	[PB80-179849]	p0698 N80-3031
PETERSEN, H. Small windmills in Denmark		PIERONI, C. A.	The few ORDC
CACTI AINCRITIC IN DOUGGIN	p0735 A80-48525	<pre>Material evaluation and testing prog riser cable</pre>	TAR TOT OTEC
PETERSON, D. G.	F4.05 200 40323	TIBEL CAPIC	p0728 A80-4835
Insat-I solar array - Design and de	velopment summary	PIERSON, E. S.	FT. ET
•	p0615 A80-48213	Liquid-metal MHD for solar and coal	- System and
PETERSON, D. R.		component status	•
Chemical energy storage for solar t			p0724 A80-4822
[SAND-79-8198]	p0652 N80-32889	PIERSON, W. R.	
PRTERSON, J. L.		Sulfate in diesel exhaust	-0535 100 5050
Applications of DOR-1 to passive so commercial buildings - Preliminar		ETTARD P O	p0575 A80-5052
connected navidings - Lietinings	p0626 A80-52831	PILAND, R. O. The solar power satellite concept -	The pact
AC/DC power converter for batteries		decade and the next decade	rec bane
[BPRI-EM-1286]	p0750 N80-31937		F0623 A80-5095
PRIRESON, T. H.		PILLAI, P. K. C.	
Research on Cu sub x S/(cd, Zn)S ph	otovoltaic	Pressure loss in a spiral solar ener	gy collector
solar energy converters			p0624 A80-5097
[LBL-10791]	p0654 N80-32927	PINE, G. D.	
PRIRICK, N.		- Assessment of integrated urban energ	
Development of steam generator comp	onents for	[ PB80-173644 ]	p0581 N80-3023
open-cycle MHD	n0723 100-10406	Comparison of solar-thermal and foss	
	p0723 A80-48186	total-energy systems for selected applications	THURSTLIGH
			p0586 N80-3287

Development of an energy consumption base for fuel cell total energy sys	and co	st data
conventional building energy system	s	 N80-32960
PINOV, A. B. Investigation of high-voltage heterop	_	
PINSON, J. D.	-	A80-47 163
Analysis of small, nonconventional el systems for remote site application	s	
PITT, W. W., JR.	-	A80-48272
Recovery of ethanol from fermentation selective sorption-desorption		s using A80-48516
Pizzivi, S.	-	
On the effects of boron and phosphoru impurities in p-type silicon materi cells	al for	solar
Current status of growth processes fo silicon		A80-46758 r grade
	p0620	A80-48789
PLACE, W.  A classification scheme for the commo hybrid heating and cooling systems	n pass	ive and
Human comfort and auxiliary control c		A80-52835
in passive solar structures		N80-29903
PLANT, R.	_	
<pre>Rnergy analysis of geothermal-electri     [COO-5085-4] PLASA, B.</pre>		N80-31915
Assessment of industrial energy conse unit processes	rvatio	n by
[ORAU/IRA-80-4(M)] PLUNLER, K. W.	p0584	N80-31939
Exxon Donor Solvent Coal Liquefaction	Proce	ss -
	p0677	A80-48430
		N80-28884
PODLESHAIA, B. S. A study of the heat-induced fracture characteristics of materials under	intens	ie
radiant heating		A80-46815
PODOLSKI, W. F. Methods of improving limestone utiliz	ation	in
fluidized-bed combustion	p06 <b>7</b> 2	A80-48170
POESENTRUP, E. The behavior of a closed-cycle gas tu	rbine	with
time derendent operating conditions [ASME PAPER 79-GT/ISR-2]	p0720	A80-45663
POLAE, J. C. An automotive transmission for automo	tive o	ıas
turbine power plants	_	A80-49724
POLABSKY, G. P.	_	
Generalized performance predictions f conversion plants using geopressure fluids		
	p0725	A80-48268
Assessment of industrial energy conse	rvatio	on by
	p0584	N80-31939
PONEBOY, B. D. Alternative configurations for sodium	-coole	d solar
	p0625	A80-52075
PONT, R. J.  Modelling the competitiveness of firs	t gene	ration
	p0718	A80-44605
POOLE. D. R. Chemical energy storage for solar the [SAND-79-8198]		onversion N80-32889
POPIESKI, Z.	•	
Automotive absorption air conditioner solar and motor waste heat		_
[NASA-CASE-NPO-15183]	p0634	N80-29843

publik N80-Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 4: Series systems [COES-4209-T1-VOL-4] p0748 N80-

p0748 N80-31273

```
PORKOLAB, M.
   Parametric decay into ion cyclotron waves and drift waves in multi-ion species plasma
                                                  p0735 180-49071
   Parametric excitation of ion quasi-mode by the pump near the ion cyclotron frequency
                                                   p0736 A80-49072
POSEKUS, A. C.
   An improved synthesis of 2,4,8,10-tetroxaspiro (5.5) undecane [HASA-CASE-ABC-11243-2] p0583 H80
POST, D.
   Experimental evidence of charge-exchange
recombination of highly ionized iron and
titanium in Princeton large torus
                                                   D0735 A80-48765
POSTOL, T. A.
   Structure of amorphous silicon and silicon hydrides
                                                   p0599 A80-46647
POTTS, J. D.
   LC-Fining of solvent refined coal - SRC-I and
      short contact time coal extracts
                                                   D0678 A80-48431
POUBBAU, P. C.
Passive radially centered magnetic suspension for
      high velocity rotors
[SWIAS-792-422-109]
                                                   p0775 N80-28930
POUBLL, D. C.
   Definition of gust model concept and review of
      gust models
[PNL-3138]
                                                   p0712 N80-33072
POWELL, J.
Fusion:
               An energy source for synthetic fuels
      [BNL-27891]
                                                  p0667 N80-33205
POWELL, J. R.
Advanced power technology for fusion reactors
                                                   p0728 A80-48359
   Blanket options for high-efficiency fusion power p0729 A80-48360
   HYFIRE - Fusion-high temperature electrolysis system p0731 A80-48448
   Pusion reactors for hydrogen production via
      electrolysis [BNL-27782]
    Advanced synfuels production/power systems
      utilizing laser particulate control [BNL-27783]
                                                   p0710 N80-32570
POBELL, B. B.
    Solar/electric district heating via CASES
                                                   p0616 A80-48286
    Community Annual Storage Energy System
                                                   p0773 A80~50910
POWER, B. M.
   A simulation model for wind turbines
                                                   p0738 · A80-50972
   TIDP - Basic research for answering Plorida's
      residential energy conservation questions
p0576 A80-51954
    Power cycles analyses by generalized thermodynamic
      properties
PRATER, R.
   Conceptual design of BST: An rf-driven,
steady-state Tokamak
[BPRI-AP-1351] p07
PRELAT, A. B.
   Geological and geothermal data use investigations
for application Explorer mission-A (heat
capacity mapping mission)
[E80-10279] p0698 N80-29
                                                   p0698 N80-29822
FRETO, S. E. Calcium/iron disulfide secondary cells
                                                   D0764 A80-48239
PRIBIS, P. B.
   The commercial application of an OTEC Jacket
      /tower/ design
PRICE, K. M.
   High temperature solar energy conversion systems
                                                   p0621 A80-48924
    A synergistic solid waste to energy project -
      Phase 1 project concept
                                                   D0570 A80-47586
```

•	•
PRIESTLEY, R. R.	BABINS, M. J.
Cogeneration Technology Alternatives Study (CTAS).	Basic Research in Engineering: Process and
Volume 2: Analytical approach	Systems Dynamics and Control. High Priority
[NASA-CR-159766] p0741 B80-28859 Cogeneration Technology Alternatives Study (CTAS).	Research Needs Relevant to Energy [FE-2468-65] p0590.N80-33167
Volume 3: Industrial processes	[PE-2468-65] p0590.N80-33167
[ WASA-CR-159767 ] p0749 #80-31870	Long-term average performance benefits of
Cogeneration Technology Alternatives Study (CTAS).	parabolic trough improvements .
Volume 4: Energy conversion systems	[SERI/TR-632-439] p0632 N80-28893
[NASA-CR-159768] p0755 N80-33859	Effect of circumsolar radiation on performance of
PRINCE, B. R. Assumptions and ground-rules used in nuclear waste	focusing collectors [SERI/TR-34-093] p0646 #80-31916
projections and source term data	Optical analysis of point focus parabolic
[ONHI-24] p0585 H80-32203	radiation concentrators
PRIOLO, B. P.	[SERI/TR-631-336] p0646 N80-31917
Department of Housing and Urban Development solar hot water initiative: Centralized coordination	BABL, V. A.
of technical tasks and system evaluation	The OASIS computer program for optimization and simulation of integrated systems
[PB80-189244] p0656 N80-32961	p0571 A80-48333
PRITCHETT, P. L.	BADER, A. M.
Linear analysis of the double-tearing mode	Peasibility of a peat biogasification process
PROTASOV, IU. S. p0718 A80-44390	p0669 A80-46197
Magnetoplasma compressor with an explosion-driven	Status of peat biogasification development r0674 A80-48293
magnetic power generator	BADOSEVICH, L. G.
p0717 A80-44185	Thermal energy storage for solar thermal
PROBITT, J. E.	applications program
Process economics and the second law in thermochemical hydrogen production - The effect	[SAND-80-8218] p0646 N80-31918
of heat transfer	BADOVSKY, I. B. Biniplant and bench studies of pressurized
p0663 A80-48459	fluidized-bed coal combustion
PRUSCHEK, R.	[PB80-188121] p0712 N80-32999
Status of nuclear high temperature process heat	RADTKE, G.
development in the Pederal Republic of Germany /coal gasification and long distance energy	The investment demand of energy economy and its financing
transport/	p0575 A80-50827
p0758 A80-48311	RAPINEJAD, D.
PUESCHEL, B. P.	Design, construction, and operation of a 150 km
Conversion of nitrogen oxide gases to nitrate	solar-powered irrigation facility, phase 2
particles in oil refinery plumes p0572 A80-48534	[ALO-4159-1] p0645 N80-31903
Pormation of sulfate particles in the plume of the	Analytical prediction of liquid
Four Corners Power Plant	photovoltaic/thermal flat-plate collector
p0576 A80-51660	performance
PUGLISI, V. J.	[COO-4094-66] p0646 N80-31913
Nickel hydrogen battery for load leveling application	Analytical prediction of the performance of an air photovoltaic/thermal flat plate collector
p0766 A80-48328	[DOB/ET-20279/93] p0653 880-32914
PULPERY, D. L.	HAGLAND, K. W.
New experimental evidence for minority carrier MIS	Pluidized bed combustion of refuse derived fuels
diodes p0600 180-46695	p0684 A80~50019
PUNNANI, D. V.	RAGSDBLL, E. B.  Computer aided optimal design of compressed air
Peat char gasification - Laboratory and PDU-scale	energy storage systems
studies	p0761 A80-45826
PRET W W	PAHILLI, N. P.
Total and non-isotropic diffuse insolation on	Radiation effects on solar cells p0609 A80-46894
tilted surfaces	BAJESHVAR, K.
p0599 A80-46571	D.C. electrical conductivity of Green River oil
PYRCIOCH, E. J.	shales
Peat char gasification - Laboratory and FDU-scale studies	p0685 A80-50278
p0674 A80-48294	Cathode sheaths in potassium seeded MHD combustion
	plasmas
Q ·	p0720 A80-46158
QUADE, R. H.	RAJVANSEL, A. K. A scheme for large scale desalination of sea water
Design of the HTGR for process heat applications	by solar energy
p0758 A80-48313	p0595, A80~45313
QUINN, R. K.	BRIDGELJUNGP J. 10
Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery	The power system p0743 H80-29387
[SAHD-79-2148C] p0746 H80-30933	BAMSDELL, J. V.
	Siting handbook for small wind energy conversion
R	systems
	[PNL-2521-REV-1] p0747 N80-30941
RAMB, A.  Combined effects of periodic and stochastic loads	RAMSET, S. C. Thin film polycrystalline silicon solar cells
on the fatigue of wind turbine parts, part 6	[SAN-2207-T4] p0638 N80-29879
[FFA-AU-1499-PT-6] p0741 N80-28732	RASCOURT, J. D.
RABENHORST, D. W.	An evaluation of spectrally selective reflectors
Energy conservation with flywheels p0773 A80-50911	(cold mirror membranes) for use with concentrator solar arrays
Low-cost flywheel demonstration program	p0659 N80-33900
[DOR/RT-26931/T1] p0778 N80-32897	
Low-cost flywheel demonstration program	
[CONS-5085-T2] P0780 N80-33909	

RAND, D. A. J. Investigation of a Philips MP 1002 CA Stirling Lead-acid traction batteries for electric road engine vehicle propulsion Directions for research and p0734 A80-48499 REAGAN, P.
Combustion performance of CVD silicon carbide development p0772 A80-48766 thermionic diodes Parabolic trough solar collector wind loading [SAND-79-2134C] p0652 N80
RANDALL, B. A. p0732 A80-48473 p0652 N80-32895 REAR, D. J.

Refining and upgrading of synfuels from coal and Multiple-tank high temperature storage subsystem oil shales by advanced catalytic processes [SAND-79-2056] .
RANDOLPH, L. P. p0775 N80-28878 [FR-2315-401 p0691 180-28550 REBHAN, B. Progress in space power technology Combined n equal to 0 and n not equal to 0 MHD stability analysis of axisymmetric surface current model equilibria p0722 A80-48173 Study of the insulating wall boundary layer in a p0719 A80-44659 Paraday MHD generator Eigenvalue bounds for Hill's equation p0722 A80-47763 D0720 A80-45851 RECK, M. W.
The 1980 technology status of the Dynamic Isotope RAO, G. M.
Electrowinning of silicon from K2SiF6-molten fluoride systems Power System p0622 A80-50510 p0725 A80-48255 RASCH, K. D. REDDY, T. S.
Economic evaluation of the MIT process for Aspects of large area and thin silicon solar cell manufacture of ethanol technologies p0658 \$80-33884 [DSE-3992-T1] p0705 N80-31647 Comparison of silicon solar cell characteristics at operating temperature after electron BEDFIELD, D.

Comprehensive explanation of efficiency limits in irradiation silicon solar cells D0659 N80~33890 D0600 A80-46697 RASCH. K .- D. Advanced thin silicon solar cell with controlled Heat pipes. Citations from the NTIS data base [PR80-809940]

Reat pipes. Citations from the NTIS data base
[PR80-809957]

Heat pipes. Citations from the Engineering Index optical absorptance D0601 A80-46710 RASMUSSRE, M.
Refuse incineration - A recycling process p0781 N80-28681 p0681 A80-49955 data base p0781 N80-28682 RISHUSSER, M. L.
Combustion of drops and sprays of no. 2 diesel oil
and its emulsions with water and methanol. [ PB80-809965] Heat pipes. Citations from the engineering index data base Volume 1: Experimental [PB80-178213] FB80-8099731 p0781 N80-28683 p0698 N80-30470 Thermionic energy conversion. Citations from the Combustion of drops and sprays of no. 2 diese and its emulsions with water and methanol. Volume 2: Theoretical [PB80-178221] p0698 NR 2 diesel oil NTIS data base [PB80-810906] Magnetchydrodynamic generators in power generation. Citations from the NTIS data base [PB80-810856] p0748 N80-30 p0698 N80-30471 p0748 N80-30954 Development of solar driven absorption air conditioners and heat pumps Bydrogen production from remote power sites [BNL-27457] p0666 p0666 N80-32553 p0642 N80-30925 [LBL-10771] RATAJCZAK, A. F.

Description of photovoltaic village power systems in the United States and Africa REGNAULT, W.

Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon p0609 180-46796 impact program [DOE/CH-00178/T2] p0654 N80-32934 REHMAT, A. Potential use of terrestrial photovoltaics for A mathematical model for the continuous combustion of char particles in a fluidized bed future space solar arrays p0658 N80-33882 RATH, L. K. p0671 A80-48168 Advanced coal gasification system for electric Historical development of the U-GAS process at the power generation [PB-1514-97] IGT pilot plant D0700 N80-30548 D0673 A80-48246 RAUCH, J. S. Harmonic analysis of Stirling engine thermodynamics Single particle gas-solid reactions and their application to modeling of fluidized bed coal combustors and ash agglomerating gasifiers p0730 A80-48408 Ng. R. D.
Hydrogen production by photoelectrolytic
decomposition of H2O using solar energy
(NRSA-CR-1635861 p0667 N80-32854 p0713 N80-33578 BBICHL, B. Research needs for coal gasification and coal RAUSCE, R. A.
Dual curvature acoustically damped concentrating liquefaction' collector REID, M. A. [DOE/CS-34196/T1] DO647 NBO-31921 Improvement, and scale-up of the NASA Redox storage RAVI. K. V. system Ion implanted solar cells from EPG silicon ribbons p0767 A80-48370 p0601 A80-46705 BBIFF, P. H. RAVICE, IU. I.
Design of a thermophotocell Environmental protection of the solar power satellite DO6 10 A80-47154 p0609 A80-46899 RAZZIBI, G. REILLY, R. B. The economics of aquifer storage of chilled water for a'ir conditioning The lithium-sulfuryl chloride battery - Discharge behaviour P0772 A80-48770 p0767 180-48337 READER, 6. T.

An algorithm for the preliminary design of The economics of compressed air energy storage with thermal energy storage p0767 A80-48339 Stirling engine heaters

P0730 A80-48411

BIDBE, A.

REIMABB, J. Efficient thermal cycling of solar panels in solar simulation facilities with a multi-panel test rig P0659 N80-33898 RELEHART2, K. K.
Photovoltaic power generators in space P0604 A80-46735 RRISHAW, A- Wa Costing methodologies for energy systems [BNL-27603] p07 p0778 #80-32900 REITTER, T. A. Effect of a heated atmosphere on the emittance of black chrome solar collector pipe surfaces
[UCRL-83506] p0631 N p0631 N80-28677 REMICE, B. J.

A hybrid water-splitting cycle using copper sulfate and mixed copper oxides p0664 A80-48503 A practical and economic method for estimating wind characteristics at potential wind energy conversion sites p0670 A80-46569 Wind characteristics program element [PNI-3211] D0754 N80-33073 REHIZ, O.
Optimization problems of emission reduction in large fossil-fuel combustion facilities p0576 A80 p0576 A80-51500 REPEREIEG, K. Energy expenditure for environmental protection -A contribution to efficiency analysis p0575 A80-50819 REVVA. M. K. Experimental studies of some regularities in the underground gasification of inclined coal seams [UCRL-TRANS-11585] p0695 N80-29 p0695 N80-29504 RESENTCHERRO, V. IA.

A 150 MW power generating gas turbine plant p0719 A80-44773 Photovoltaic systems design and performance p0611 A80-47597 Scoping study of a tandem-mirror fusion reactor coupled to a thermochemical hydrogen synfuel plant p0662 A80-48406 RICE, M. J. Thin film polycrystalline silicon solar cells
[SAB-2207-T4] p0638 N8 p0638 880-29879 RICHARDS, D.

Design of 40-HW grazing and moored OTEC pilot/demonstration plants p0727 A80-48348 National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Proceedings p0626 A80-52626 RICHARDS, J. R. Photochemical study of NOx removal from stack gases [PB80-181274] p0582 N80-30966 [ PB80-181274 ] RICHARDS, W. D. Stirling engine power system development and test results p0731 A80-48453 BICHARDSON, H. H. Basic Research in Engineering: Process and Systems Dynamics and Control. High Priority Research Beeds Relevant to Energy [FB-2468-65] p0590 N80-33167 BICHARDSON, P. W.

Design, performance and life cycle cost
relationships for a 500kW space solar array p0617 A80-48356 RICHTER, E. Regenerative flywheel energy storage system [UCBL-13982-REV-1]. p0775 N80-28884 RICHTER, G. P.

JT9D-7A /SP/ jet engine performance deterioration trends p0569 A80-44230 RICKMAN, W. S.
Selecting fines recycle methods to optimize fluid ted combustor performance p0671 A80-48169

Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [RLO-2438-78/1] n0706 NBO-31900 RIDGEAY, S. L.
The mist-lift OTEC cycle p0718 A80-44602 BIRDL, F. J.
Upgrading of coal liquids: Hydrocracking of EDS process derived gas oils [PB-2566-33] p0699 N80-30545 RIPKIN, O. Analysis and design of free-piston Stirling engines - Thermodynamics and dynamics p0729 480-48407 Applications of free-piston Stirling engines p0732 A80-48456 An advanced 15 kW solar powered free-piston Stirling engine D0619 A80-48467 RIMBER, D.

The CS/R advanced SHG hydrogasification process
n6674 A80p0674 A80-48292 RIBE, J. Bission analysis of the P78-2 power subsystem after one year of operation D0765 A80-48310 RIORDAN, M. National Passive Solar Conference, 3rd, San Jose, Calif., January 11-13, 1979, Eroceedings p0626 A80-52826 RIOS, H., JR.
US National Photovoltaics Program and applications experiments in the intermediate sector [SAND-80-0587C] p06 p0654 N80-32935 Simple economic evaluation and applications experiments for photovoltaic systems for remote sites [ SAND-80-0749C] E0655 N80-32937 EITTERNAB, P. F.
Cycling characteristics of nickel-hydrogen cells p0771 A80-48444 EIVERAU, J.-C.
Landsat imagery in oil exploration - Six years of experience P0685 A80-50880 RIVIERE, A. C.
Particle confinement scaling experiments in the
Culham Levitron p0719 A80-44657 ROBBIES, W. H.
Large wind turbines: A utility option for the generation of electricity [NASA-TM-81502] p0752 N80-32858 ROBERT. A. Study on the utilization of solar energy for the Operation of Spacelab material science furnaces [BSA-CE(P)-1301] p0640 N80-30 p0640 N80-30348 ROBERTS, &. P.

Haterial evaluation and testing program for OTEC riser cable p0728 A80-48351 ROBERTSON, J. Comparison of coal-fired power systems in waste heat applications in Tacoma, Washington [TID-29379] p0693 p0693 N80-28858 ROBINSON, K. K. Catalyst development for coal liquefaction [ BPRI-AF- 1233] p0696- N80-29508 ROBINSON, S. L.
Materials-related design issues in the solar central receiver pilot plant p0623 A80-50800 Calcium/iron disulfide secondary cells p0764 A80-48239 Evaluation of high temperature LiAl/TiS2 cells P0773 A80-50508 ROCKEY, D. B. Concentrator-enhanced photovoltaic arrays for deep space applications p0614 A80-48210 BODGERS, B. R. Assessment of current research and development in support of the U.S. coal liquefaction demonstration plants program

p0677 A80-48428

PERSONAL AUTHOR INDEX BUBERTO, R.

RODZIANKO, P.
The challenge of financing geothermal development BOSS, J. Research needs for coal gasification and coal p0727 A80-48317 liquefaction p0688 A80-53274 Operational characteristics of a 60 km photovoltaic system integrated with a utility grid BOSS, L. B.
Calcium/iron disulfide secondary cells p0609 A80-46797 p0764 A80-48239 BOBSSBER, D.

Basic research needs and priorities in solar energy. Volume 1: Executive summary.

Technology crosscuts for DOE
[SERI/TE-351-358-VOL-1] p0645 N80-31898

Basic research needs and priorities in solar energy. Volume 2: Technology crosscuts for DOE
[SERI/TE-351-358-VOL-2] p0645 N80-31899 BOSS, P. N..
The kinetics of the 02/C02 reaction in molten carbonate - Reaction orders for 02 and C02 on NiO p0726 A80-48284 ROSS, R. G., JR.
Testing flat plate photovoltaic modules for terrestrial environment p0608 A80-46788 ROGALSKI, W. W. ROSS. R. T. U.S. Department of Energy ocean waves and ocean currents energy conversion programs - An overview p0740 A80-53678 Efficiency of quantum-utilizing solar energy converters in the presence of recombination losses p0610 A80-46953 ROGERS, H.
Nickel hydrogen battery advanced development program status report ROSSI, C. Co-combustion trials of pretreated solid urban refuse, ол a brown coal-fired boiler p0770 A80-48439 p0681 A80-49957 ENVIRONMENTAL effects of space systems -ROGERS, H. H. Establishment of parameters for production of long s - A review p0757 A80-46880 life nickel oxide electrodes for nickel-hydrogen BOTHWARP, A. Optimal material properties for CdS/Cu2S solar cells p0771 A80-48445 ROGERS, E., JR.
Hawaii Geothermal Froject 'A' wellhead generator p0603 A80-46726 ROTTENDORF, H feasibility project Catalytic hydrogenation of Liddell bituminous coal p0727 A80-48316 - Effects of process variables on coal dissolution in batch autoclaves ROGERS, J. D.
Tokamak poloidal field systems
[LA-8375-PE] P0679 A80-49627 ROTTY, R. H. p0754 N80-33233 ROHATGI, H. D. Constraints on carbon dioxide production from . Advanced coal gasification system for electric fossil fuel use power generation [FE-1514-97] [ ORAU/IEA-80-9 (M) ] p0589 N80-32983 D0700 N80-30548 ROUSE, S. L. Three computer codes to read, plot and tabulate operational test-site recorded solar data ROHLER, D. R. Automated multi-sample gas chromatographic analysis of fossil fuel gases [NASA-TM-78293] p0644 N80-31879 ROUSSEAU, R. W.

Coal gasification/gas cleanup test facility:
Volume 1. Description and operation
[PB80-188378] p0707 No. [HLE-2721] p0702 N80-31506 ROHY. D. A. Automotive storage of hydrogen using modified magnesium bydrides [SAN-1167-1] p0707 N80-31990 p0666 N80-31650 BOUYER, C. The SNIAS magnetic bearing wheel [SNIAS-792-421-101] ROMBY, I.
Status of coal hydrogenation in Europe p0775 N80-28929 p0669 A80-45512 BOVABĪ, Y. ROBEY, J. B.
The Cold Water Pipe - Ocean engineering status and Financing of energy investments - Capital and policy requirements of developing countries developments p0573 A80-49395 p0740 A80-53684 RONY. P. B. The lithium-sulfuryl chloride battery - Discharge Development and application of analytical techniques to chemistry of donor solvent behaviour E0772 A80-48770 liquefaction ROBAN, L. C. Remote sensing and mineral exploration; Proceedings of the Workshop, Bangalore, India, May 29-June 9, 1979 [FE-2696-T4] p0695 N80-29472 ROSA . R. Estimating solar irradiation sums from sunshine and cloudiness observations p0686 A80-51076 D0625 A80~51685 Scoping study of a tandem-mirror fusion reactor ROSATI. R. H. coupled to a thermochemical hydrogen synfuel plant po662 A80-48406 AC/DC power converter for batteries and fuel cells
[EPRI-BM-1286] p0750 N80-31937 ROSE, P. H.
TRACT -A small fusion reactor based on near-term ROWLAND, R. A. System design of The Electric Test Vehicle - One /BTV-1/ engineering p0733 A80-48493 [ SAE PAPER 800057 1 D0772 A80~49718 ROSECHANCE, A. B.
Organic material emissions from holding ponds at BOY, D. J. Georgetown University's experience in the atmospheric fluidized bed combustor technology coal-fired power generation facilities [EPRI-BA-1377] p05 p0589 N80-32987 p0675 A80-48332 BOY, G. D.

Heat transfer as a diagnostic tool in the
development of direct coal-fired MHD combustors
[ASER PAPER 80-HT-125] p0722 A80-48 ROSENTHAL, J.
Pacific Missile Test Center energy projects. Summary of projects, contributions, and plans
[AD-A086196] p0581 880-30903 p0722 A80-48040 ROSBY, R. ROY. K. An advanced technology iron-nickel battery for electric vehicle propulsion Advanced thin silicon solar cell with controlled optical absorptance p0766 A80-48327 p0601 A80-46710 Aspects of large area and thin silicon solar cell ROSS, D. K. Energy budget procedures and performance criteria for energy conserving building illumination technologies p0658 N80-33884 BUBERTO, R. systems [PB80-1842291 p0583 N80-31673 Investigation of mechanisms of hydrogen transfer in coal hydrogenation [PE-2305-33]

p0697 H80-29517

Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 SAR. E. Pluorescent planar concentrators - Performance and [FE-2305-30] p0710 H80-32568 experimental results RUBIN, J. H. D0604 A80-46741 Hydroprocessing of light pyrolysis fuel oil for kerosene type jet fuel
[AD-A089101] p0713 M80-33 SABAI, R.

20 kW gallium arsenide photovoltaic dense array
for central receiver concentrator applications p0713 N80-33599 RUBI, S.
Status of electrochemical energy storage systems for electric vehicle, solar, and electric p0608 A80-46793 SAIST-BLANQUET, C.
Transfer function of a sensible-heat storage element in periodic regime D0765 A80-48325 P0774 A80-52974 RUDAKOV, L. I. SAKAI. S. Magnetic-pressure acceleration of cylindrical Theoretical analysis of new wavelength-division liners by the pulse generators for relativistic solar cells electron beans p0622 A80-50745 P0736 A80-49098 SAKATA. T. RUDBICKI, M. I. Conversion of carbohydrate into hydrogen fuel by a Study of gelled LEG [DOE/EV-02057/T2] BUDY, C. B. photocatalytic process p0695 N80-29506 p0661 A80-44598 SALA. G. Refining and upgrading of synfuels from coal and High efficiency transcells and vertical oil shales by advanced catalytic processes. Laboratory and pilot plant studies of the processing of SRC-1 multijunction cells for double-sided concentrated illumination p0606 A80-46768 [PB-2315-45] p0699 880-30544 SALAMA, A. M. RUEDA, P.
Optical and calorimetric measurements of cupreous Improving the efficiency of silicon solar cells containing chromium
[NASA-CASE-NPO-15179-1] sulphides thin films p0650 N80-32850 p0607 A80-46779 Combined n equal to 0 and n not equal to 0 MHD Simplified energy design economics: Principles of economics applied to energy conservation and solar energy investments in buildings
[PB80-179245] p0634 B80-295 stability analysis of axisymmetric surface current model equilibria p0719 A80-44659 p0634 B80-29534 SALEMBE, R. 8. Alternative configurations for sodium-cooled solar RUITBERG, A. P. Design and performance of the International
Sun-Barth Explorer power systems thermal power plants p0625 A80-52075 p0765 A80-48307 SALERHO, V. R012. J. M. The layer perovskites as thermal energy storage High efficiency transcells and vertical multijunction cells for double-sided concentrated illumination systems p0761 A80-45315 SALIBVA, R. B.
Analytic representation of distribution laws for p0606 A80-46768 energy structure of solar-radiation regime p0611 A80-47161 Possible means of cutting energy costs and saving primary energy in waste water purification SALISBORY, J. D. p0575 A80-50818 An analysis of aluminum-air battery propulsion ROMSBY, P. T. systems for passenger vehicles p0771 A80-48471 Solaser power Comparative analysis of aluminum-air battery propulsion systems for passenger vehicles p0622 A80-50627 RUSSAR, M. A. p0778 N80-32907 Electrochemical photovoltaic cells cdSe thin film [UCRL-52933] Analysis of aluminum-air battery propulsion electrodes [DSE-4042-T16] p0654 N80-32925 systems for passenger vehicles [ UCRL-83824 ] p0778 880-32940 RUTH, J. Satellite power systems for Western Europe - Problems and solution proposals SALLES, Y. Study of sandwich type glass encapsulation p0602 A80-46714 Improvement of phosphorus diffused silicon solar D0622 A80-50633 Miniplant and beach studies of pressurized cells by laser treatment fluidized-bed coal combustion p0606 A80-46763 [PB80-188121] p0712 N80-32999 BUTH, R. P.
Thin films of InP for photovoltaic energy conversion p0642 880-30912 A high volume process for silicon solar cells using solid diffusion sources [COC-3004-2] p0601 A80-46707 Engineering prototype studies on the CaCl2-CH3OH chemical heat pump for solar air conditioning, heating, and storage Integration of photovoltaic generation into a large generating system p0604 A80-46743 SALVADOR, L. A. p0616 A80-48289 Advanced coal gasification system for electric power generation [FE-1514-97] p0700 N80-30548 SAARI, D. P. Advanced coal gasification system for electric Development of the high temperature air heater for power generation [FB-1514-113] open cycle MHD p0709 · N80-32557 p0724 A80-48224 SABBBLLS, A. P. SACCENTI, G. Wind energy for electric vehicle recharge p0726 A80-48273 Co-combustion trials of pretreated solid urban refuse, on a brown coal-fired boiler Blectrochemical photovoltaic cells, project 65021 [DSE-4042-T8] p0742 N80-28910 p0681 A80-49957 [DSE-4042-T8] SAMPLE, D. G.
Catalyst characterization in coal liquefaction SADLER, J. W.
MHD electrode development [FE-15529-5] p0748 N80-31222 [SAND-80-0123] p0709 N80-32560 SADOUSKI, B. P. SAMPSON, R. S., JR. Weld overlaying for corrosion resistance in coal gasification atmospheres Three computer codes to read, plot and tabulate operational test-site recorded solar data p0644 B80-31879 [PE-2621-13] p0711 880-32726 [ NASA-TH-78293]

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SAMRAJ, A. C.	
A horizontal axis sail windmill for w	se in
irrigation	-0702 200 20000
[NAL-TH-54] SAMSA, M.	p0743 N80-29844
Selection of alternative central-stat	ion
technologies for the Satellite Power	
(SPS) comparative assessment	-0500 200 00007
[DOE/ER-0052] Hethodology for the comparative asses	p0580 N80-29887
Satellite Power System (SPS) and al	ternative
technologies	
[ NASA-CR-163049]	p0750 N80-31951
SAN MARTIN, R. Solar opportunities - Domestic and in	ternational
pordr opportunities seasons and re	p0625 .180-51951
SANADA, I.	
Qualitative and quantitative assessment	
reaction models of coal hydrogenati	p0679 A80-49629
SANDARL, C. A.	P0073 R00 43023
Status of the satellite power system	concept
development and evaluation program	-0400 100 50050
SAEDBERG, J. J.	p0623 A80-50952
Trade-off results and preliminary des	signs of
Near-Term Hybrid Vehicles	
[SAE PAPER 800064]	p0772 A80-49723
Vehicles testing of near-term batter: [SAE PAPER 800201]	D0773 A80-49730
SANDBORN, V. A.	PO 113 MOU-43130
Sites for wind-power installations:	Physical
modeling of the influence of hills, complex terrain on wind speed and f	, ridges and
complex terrain on wind speed and the Part 1: Executive summary	urbulence.
	p0706 N80-31900
	Wind
characteristics over ridges, part	
[RLO-2438-78/2]	p0706 N80-31901
SAMDERS, J. A. 470-kW photovoltaic power system for	Saudi Arabia
villages	7.
<u> </u>	
	p0616 A80-48232
SANDERSON, J. B.	PU 6 16" A 80-48232
Liquid fuels production from biomass	•
Liquid fuels production from biomass [COO-4388-10] SAMDERSON, R. A.	p0708 #80-32545
Liquid fuels production from biomass [COO-4388-10] SAMPERSON, B. A. Development of molten carbonate fuel	p0708 #80-32545
Liquid fuels production from biomass [COO-4388-10]  SANDERSON, R. A.  Development of molten carbonate fuel plant technology	p0708 #80-32545 cell power
Liquid fuels production from biomass [COO-4388-10]  SANDERSON, R. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]	p0708 #80-32545
Liquid fuels production from biomass [COO-4388-10]  SANDERSON, R. A.  Development of molten carbonate fuel plant technology	p0708 880-32545 cell power p0750 880-31938
Liquid fuels production from biomass [COO-4388-10]  SAHDERSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SAHDSTROM, W. A.	p0708 880-32545 cell power p0750 880-31938 process at the
Liquid fuels production from biomass [COO-4388-10]  SAHDERSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SAHDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant	p0708 880-32545 cell power p0750 880-31938
Liquid fuels production from biomass [COO-4388-10]  SANDERSON, R. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant  SANGERDOR, J.	p0708 %80-32545 cell power p0750 %80-31938 process at the p0673 %80-48246
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant  SANGRADON, J.  High efficiency transcells and vertic multijunction cells for double-side	p0708 %80-32545 cell power p0750 %80-31938 process at the p0673 %80-48246
Liquid fuels production from biomass [COO-4388-10]  SAHDERSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SAHDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant	p0708 %80-32545 cell power p0750 %80-31938 process at the p0673 %80-48246 cal
Liquid fuels production from biomass [COO-4388-10]  SANDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Bistorical development of the U-GAS   IGT pilot plant  SANGRADOB, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination	p0708 %80-32545 cell power p0750 %80-31938 process at the p0673 %80-48246
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROM, W. A.  Bistorical development of the U-GAS in the plant plant  SANGRADON, J.  High efficiency transcells and vertical multijunction cells for double-side concentrated illumination  SANSONE, M. J.	p0708 880-32545 cell power p0750 880-31938 process at the p0673 880-48246 cal p0606 880-46768
Liquid fuels production from biomass [COO-4388-10]  SANDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Bistorical development of the U-GAS   IGT pilot plant  SANGRADOB, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination	p0708 880-32545 cell power p0750 880-31938 process at the p0673 880-48246 cal p0606 880-46768
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROM, W. A.  Bistorical development of the U-GAS   IGT pilot plant  SANGEADON, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SANSONE, B. J.  Alternative process schemes for coal [BNL-51117]  SANTAVICCA, D. A.	p0708 880-32545 cell power p0750 880-31938 process at the p0673 880-48246 cal ad p0606 880-46768 conversion p0692 880-28560
Liquid fuels production from biomass [COO-4388-10]  SANDERSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROM, W. A.  Bistorical development of the U-GAS [IGT pilot plant  SANGRADOR, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SANSONE, B. J.  Alternative process schemes for coal [BNI-51117]  SANTAVICCA, D. A.  Formation and control of fuel-nitrogeness and several contents of the contents	p0708 880-32545  cell power  p0750 880-31938  process at the  p0673 880-48246  cal  p0606 880-46768  conversion  p0692 880-28560  en pollutants
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SABDEBSON, W. A.  Historical development of the U-GAS restricted development of the U-GAS restricted for plant  SABGRADOB, J.  High efficiency transcells and vertice multijunction cells for double-side concentrated illumination  SABSONE, M. J.  Alternative process schemes for coal [BNI-51117]  SABTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-determine computation of coal-determine computation of coal-determine catalytic combustion catalytic c	p0708 880-32545 cell power p0750 880-31938 process at the p0673 880-48246 cal ad p0606 880-46768 conversion p0692 880-28560 en pollutants rived gases
Liquid fuels production from biomass [COO-4388-10]  SABDERSON, B. A.  Development of molten carbonate fuel plant technology [DOF/ET-15440/1]  SANDSTROB, W. A.  Bistorical development of the U-GAS [IGT pilot plant  SANGRADON, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SANSONE, M. J.  Alternative process schemes for coal [BNI-51117]  SANTANICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-det [FE-2762-8]  SAPINEXA, B.	p0708 %80-32545 cell power p0750 %80-31938 process at the p0673 %80-48246 cal ad p0606 %80-46768 conversion p0692 %80-28560 an pollutants rived gases p0577 %80-28557
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SABSTROB, W. A.  Bistorical development of the U-GAS   IGT pilot plant  SAMGRADOB, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SABSOBB, M. J.  Alternative process schemes for coal [BNI-51117]  SABTAVICCA, D. A.  Pormation and control of fuel-nitroge in catalytic combustion of coal-det [FE-2762-8]  SAPIENZA, B.  Soot reduction in diesel engines by company technology and the same production in diesel engines by control of the same produc	p0708 %80-32545 cell power p0750 %80-31938 process at the p0673 %80-48246 cal ad p0606 %80-46768 conversion p0692 %80-28560 an pollutants rived gases p0577 %80-28557
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant  SANGRADOB, J.  High efficiency transcells and vertice multijunction cells for double-side concentrated illumination  SANSOBE, M. J.  Alternative process schemes for coal [BNL-51117]  SANTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-der [FE-2762-8]  SAPIREZA, B.  Soot reduction in diesel engines by coeffects	p0708 880-32545 cell power p0750 880-31938 process at the p0673 880-48246 cal ed p0606 880-46768 conversion p0692 880-28560 en pollutants rived gases p0577 880-28557 catalytic
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROM, W. A.  Bistorical development of the U-GAS   IGT pilot plant  SANGRADON, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SANSONE, A. J.  Alternative process schemes for coal [BNI-51117]  SANTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-det [PE-2762-8]  SAPIREZA, R.  Soot reduction in diesel engines by ceffects [BNI-27792]	p0708 %80-32545 cell power p0750 %80-31938 process at the p0673 %80-48246 cal ad p0606 %80-46768 conversion p0692 %80-28560 an pollutants rived gases p0577 %80-28557
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SAHDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant  SAMGRADOB, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SANSOBE, M. J.  Alternative process schemes for coal [BNI-51117]  SANTAVICCA, D. A.  Pormation and control of fuel-nitroge in catalytic combustion of coal-det [PE-2762-8]  SAPIBEZA, B.  Soot reduction in diesel engines by ceffects [BNI-27792]  SAPONITE, A. D.	p0708 880-32545 cell power p0750 880-31938 process at the p0673 880-48246 cal ed p0606 880-46768 conversion p0692 880-28560 en pollutants rived gases p0577 880-28557 catalytic p0585 880-32731
Liquid fuels production from biomass [COO-4388-10]  SABBESON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Bistorical development of the U-GAS   IGT pilot plant  SANGRADON, J.  High efficiency transcells and verticular multijunction cells for double-side concentrated illumination  SANSONE, B. J.  Alternative process schemes for coal [BNL-51117]  SANTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-def [FE-2762-8]  SAPIENZA, B.  Soot reduction in diesel engines by ceffects  [BNL-27792]  SAPONITH, A. D.  High energy density composite flywhee [AD-A087076]	p0708 880-32545 cell power p0750 880-31938 process at the p0673 A80-48246 cal ad p0606 A80-46768 conversion p0692 880-28560 en pollutants rived gases p0577 880-28557 catalytic p0585 880-32731
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SABSTROB, W. A.  Bistorical development of the U-GAS [IGT pilot plant  SAMGRADOB, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SABSOBE, M. J.  Alternative process schemes for coal [BNI-51117]  SABTAVICCA, D. A.  Pormation and control of fuel-nitroge in catalytic combustion of coal-det [FE-2762-8]  SAPIBEZA, B.  Soot reduction in diesel engines by ceffects [BNI-27792]  SAPONITH, A. D.  High energy density composite flywhee [AD-A087076]  SARBA, K. B.	p0708 880-32545  cell power  p0750 880-31938  process at the  p0673 A80-48246  cal  p0606 A80-46768  conversion p0692 880-28560  en pollutants rived gases p0577 N80-28557  catalytic  p0585 N80-32731  pl program p0777 880-31892
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant  SANGRADOB, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SANSOBE, M. J.  Alternative process schemes for coal [BNL-51117]  SANTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-der [FE-2762-8]  SAPIRNIA, B.  Soot reduction in diesel engines by coeffects [BNL-27792]  SAPOHITH, A. D.  High energy density composite flywher [AD-A087076]  SARMA, K. B.  Thin film polycrystalline silicon sol	p0708 880-32545 cell power p0750 880-31938 process at the p0673 A80-48246 cal ad p0606 A80-46768 conversion p0692 880-28560 en pollutants rived gases p0577 880-28557 catalytic p0585 880-32731 el program p0777 880-31892 lar cells
Liquid fuels production from biomass [COO-4388-10]  SANDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Historical development of the U-GAS right plot plant  SANGRADOB, J.  High efficiency transcells and vertice multijunction cells for double-side concentrated illumination  SANSOBE, M. J.  Alternative process schemes for coal [BNL-51117]  SANTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-der [FE-2762-8]  SAPINNA, B.  Soot reduction in diesel engines by ceffects [BNL-27792]  SAPONITH, A. D.  High energy density composite flywher [AD-A087076]  SARMA, K. B.  Thin film polycrystalline silicon sol [SN-2207-741]	p0708 880-32545  cell power  p0750 880-31938  process at the  p0673 880-48246  cal  p0606 880-46768  conversion  p0692 880-28560  en pollutants  rived gases  p0577 880-28557  catalytic  p0585 880-32731  el program  p0777 880-31892  lar cells  p0638 880-29879
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SAHDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant  SAMGRADOB, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SAMSOBE, M. J.  Alternative process schemes for coal [BNL-51117]  SAMTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-det [FE-2762-8]  SAPIBEXA, B.  Soot reduction in diesel engines by ceffects [BNL-27792]  SAPOHITH, A. D.  High energy density composite flywher [AD-A087076]  SARBA, E. B.  Thin film polycrystalline silicon sol [SAM-2207-74]  SABBA, P. B. L.  End effects in a BBD channel with diesel effects in a BBD ch	p0708 880-32545  cell power  p0750 880-31938  process at the  p0673 880-48246  cal  p0606 880-46768  conversion  p0692 880-28560  en pollutants  rived gases  p0577 880-28557  catalytic  p0585 880-32731  el program  p0777 880-31892  lar cells  p0638 880-29879
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant  SANGRADOB, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SANSOBE, M. J.  Alternative process schemes for coal [BNL-51117]  SANTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-der [FE-2762-8]  SAPIRNIA, B.  Soot reduction in diesel engines by coeffects [BNL-27792]  SAPOHITH, A. D.  High energy density composite flywher [AD-A087076]  SARMA, K. B.  Thin film polycrystalline silicon sol	p0708 880-32545  cell power p0750 880-31938 process at the p0673 880-48246  cal ad p0606 880-46768  conversion p0692 880-28560  an pollutants rived gases p0577 880-28557  catalytic p0585 880-32731  el program p0777 880-31892  lar cells p0638 880-29879  perging
Liquid fuels production from biomass [COO-4388-10]  SANDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Historical development of the U-GAS plant technology [Does are also be a second of the U-GAS plant technology [Does are a second of the U-GAS plant technology [Does a second of the U	p0708 880-32545  cell power  p0750 880-31938  process at the  p0673 880-48246  cal  p0606 880-46768  conversion  p0692 880-28560  en pollutants  rived gases  p0577 880-28557  catalytic  p0585 880-32731  el program  p0777 880-31892  lar cells  p0638 880-29879
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Historical development of the U-GAS restricted for plant  SANGRADOR, J.  High efficiency transcells and vertice multijunction cells for double-side concentrated illumination  SANSONE, M. J.  Alternative process schemes for coal [BNL-51117]  SANTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-der [FE-2762-8]  SAPIRNEA, B.  Soot reduction in diesel engines by coeffects [BNL-27792]  SAPONITH, A. D.  High energy density composite flywhere [AD-A087076]  SARMA, E. B.  Thin film polycrystalline silicon sol [SAN-2207-14]  SABMA, P. B. L.  End effects in a MBD channel with divelectrode walls	p0708 880-32545 cell power p0750 880-31938 process at the p0673 880-48246 cal p0606 880-46768 conversion p0692 880-28560 en pollutants rived gases p0577 880-28557 catalytic p0585 880-32731 el program p0777 880-31892 lar cells p0638 880-29879 perging p0738 880-50948
Liquid fuels production from biomass [COO-4388-10]  SANDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROB, W. A.  Historical development of the U-GAS plant technology [Does are also be a second of the U-GAS plant technology [Does are a second of the U-GAS plant technology [Does a second of the U	p0708 880-32545 cell power p0750 880-31938 process at the p0673 A80-48246 cal ad p0606 A80-46768 conversion p0692 880-28550 en pollutants rived gases p0577 880-28557 catalytic p0585 880-32731 el program p0777 880-31892 lar cells p0638 880-29879 perging p0738 A80-50948 Lline TiO2
Liquid fuels production from biomass [COO-4388-10]  SABDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SAHDSTROB, W. A.  Historical development of the U-GAS   IGT pilot plant  SAMGRADOB, J.  High efficiency transcells and vertice multijunction cells for double-side concentrated illumination  SAMSOBE, M. J.  Alternative process schemes for coal [BNL-51117]  SAMTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-deterory [FE-2762-8]  SAPIBEZA, R.  Soot reduction in diesel engines by ceffects [BNL-27792]  SAPOHITH, A. D.  High energy density composite flywhere [AD-A087076]  SARBA, K. B.  Thin film polycrystalline silicon sol [SAM-2207-T4]  SABBA, P. B. L.  End effects in a MAD channel with directorde walls  SATO, B.  Visible light response of polycrystal electrodes	p0708 880-32545 cell power p0750 880-31938 process at the p0673 880-48246 cal p0606 880-46768 conversion p0692 880-28560 en pollutants rived gases p0577 880-28557 catalytic p0585 880-32731 el program p0777 880-31892 lar cells p0638 880-29879 perging p0738 880-50948
Liquid fuels production from biomass [COO-4388-10]  SANDEBSON, B. A.  Development of molten carbonate fuel plant technology [DOE/ET-15440/1]  SANDSTROM, W. A.  Bistorical development of the U-GAS   IGT pilot plant  SANGEADOR, J.  High efficiency transcells and vertic multijunction cells for double-side concentrated illumination  SANSONE, B. J.  Alternative process schemes for coal [BNL-51117]  SANTAVICCA, D. A.  Formation and control of fuel-nitroge in catalytic combustion of coal-der [PE-2762-8]  SAPINEZA, B.  Soot reduction in diesel engines by ceffects [BNL-27792]  SAPONITH, A. D.  High energy density composite flywher [AD-A087076]  SARBA, K. B.  Thin film polycrystalline silicon sol [SAN-2207-T4]  SABBA, P. B. L.  End effects in a MAD Channel with director de walls  SATO, B.  Visible light response of polycrystal	p0708 880-32545  cell power  p0750 880-31938  process at the  p0673 A80-48246  cal  p0606 A80-46768  conversion p0692 880-28560  en pollutants rived gases p0577 880-28557  catalytic  p0585 880-32731  el program p0778 880-31892  lar cells p0638 880-29879  verging  p0738 A80-50948  line Tio2 p0664 A80-51691

p0726 A80-48281

```
SATE, R. F.
    The solution to the gas turbine temperature problem
p0738 A80-50949
    Thermionic converter output as a function of
       collector temperature
                                                         p0732 A80-48476
SAUBDRES, H. T.
The energy efficient engine project
[BASA-TH-81566]
                                                         p0585 N80-32395
SAVALĜI, N. L.
    The power system
                                                         p0743 B80-29387
SIVANT, C.

Pacific Missile Test Center energy projects.

Summary of projects, contributions, and plans
[10-1086196] p0581 180-30903
SAVELLI, Harmonian Bodel for the photovoltaic effect in Cu2S-CdS solar cells in the backwall configuration p0607 A80-46775
SAMENA, R. R.
Bigh-efficiency AlGahs/Gahs concentrator solar
cells by organometallic vapor phase epitamy
p0610 A80-46952
SAXENA, S. C.
    A mathematical model for the continuous combustion of char particles in a fluidized bed
    Oride semiconductors in photoelectrochemical conversion of solar energy
SCARBOROUGH, S. B.
Solar-powered Rankine engine assists air
conditioning systems with electrical generating
       capability
                                                         p0611 A80-47596
SCHARPER, J. W.
    The energy efficient engine project [NASA-TH-81566]
                                                         ·p0585 N80-32395
SCHARPPER, J. B.
    A synergistic solid waste to energy project -
Phase 1 project concept
                                                         p0570 A80-47586
SCHAPLOWSKY, R. K.
Study of gelled LNG
[DOB/EV-02057/T2]
                                                          p0695 N80-29506
SCHARL, G.
    Preparation and analysis of Cu20 thin-film solar
       cells
    Development of a compressed air energy storage power generation plant - The PEPCO demonstration plant study
                                                          p0767 A80-48338
SCHRIBEL, B. G.
Research and development of an advanced process
       for the conversion of coal to synthetic gasoline
       and other distillate fuels
    [FE-2306-38] p0696 M80-
Research and development of an advanced process
                                                          p0696 N80-29513
       for the conversion of coal to synthetic gasoline and other distillate fuels
       [FE-2306-35]
                                                         p0696 N80-29514
SCHEBBER, W.

Development of high temperature resistant, solar
       absorber surfaces
       [BMFT-FB-T-79-70]
                                                         p0640 N80-29906
SCHIFF, R.
    Hydrogen production by photoelectrolytic decomposition of H2O using solar energy [HASA-CE-163586] p0667 N8O-32854
SCHILLER, S. R.

Revaluation of control strategies for solar
collector loops
[LBL-10716]
SCHILLING, B.
                                                          c0647 N80-31932
    Comparison of silicon solar cell characteristics
       at operating temperature after electron
       irradiation
                                                         p0659 N80-33890
SCHIEDLEE, H. D.
Advanced coal liquefaction processes emphasize low
       hydrogen consumption
                                                         p0676 A80-48380
```

P0718 A80-44429

·	
Development research program for clean industrial	SCHREIBER, J. D.
and transportation fuels from coal [PB-2514-31] p0691 880-28554	A hybrid water-splitting cycle using copper sulfate and mixed copper oxides
SCHINDROPP, B.	p0664 A80-48503
Pluid temperature control for parabolic trough solar collectors	SCHRIBE, B. L. Development of a falling-bed fusion blanket system
[SAHD-79-2006C] p0652 N80-32894	for synthetic fuel production
SCHINGEN, L. LBG cold, an unutilized energy potential	p0678 AB0-48447 SCHREIBR, J. B.
p0671 A80-47776	Plasma-sprayed coatings for very high temperature
SCHHEIDER, L. The use of computer-controlled manipulators in	solar absorbers [COMP-791021-3] p0631 M80-28875
underwater technology	SCHRIDER, L. A.
[DFVLR-HITT-78-02] p0714 880-34117 SCHHID, F.	A successful eastern in situ coal gasification field trial
Low-cost, high-efficiency silicon by heat exchanger method and fixed abrasive slicing '	p0675 A80-48342 SCEUBERT. G.
technique	A problem posed by vapour-dominated geothermal
. p0600 A80-46700 SCHHIDT, H.	systems p0689 A80-54063
A refuse incineration plant in combination with	SCHOLLER, I. K.
district heating demonstrated by the Iserlohn	Structure of amorphous silicon and silicon hydrides
Plant p0681 A80-49964	p0599 A80-46647 SCHULTE, K. B.
SCHHIDT, B. P. Possibilities of high temperature waste	Bigh-temperature thermochemical water splitting cycle fusion reactor design considerations
incineration with the FLK-process p0682 180-49989	p0663 A80-48449 SCHUSTER, J. R.
SCHRIDT, P. S.	Fluid selection for a 100 MW/e/ line focus solar
Thermodynamic and economic analysis of heat pumps for energy recovery in industrial processes	central power station p0630 A80-53572
[ASHE PAPER 78-WA/HT-64] p0686 A80-52049 SCHHITT, C. B.	Hydrogen production by the GA sulfur-iodine process
Plasma-sprayed coatings for very high temperature	[GA-A-15777-REV] p0666 B80-31651 SCHWAGER. I.
solar absorbers [COMP-791021-3] p0631 M80-28875	Development of new catalysts for coal liquids refining
SCHRITT, R. C.	[PE-2595] p0691 N80-28553
Heat pumps in low temperature applications p0723 A80-48184	SCHEARTS, D.  Engineering prototype studies on the CaCl2-CH3OH
SCHIELDER, A.	chemical heat pump for solar air conditioning,
Research and development of an advanced process for the conversion of coal to synthetic gasoline and other distillate fuels	heating, and storage p0616 A80-48289 SCHWARE, R.
[PE-2306-38] p0696 H80-29513	Design considerations for a near-term hybrid vehicle
, Research and development of an advanced process for the conversion of coal to synthetic gasoline	P0571 A80-48420 SCHWAREE, E. W.
and other distillate fuels	System design of The Electric Test Vehicle - One
[PE-2306-35] p0696 B80-29514 SCHBELL, P.	/ETV-1/ [SAE PAPER 800057] p0772 A80-49718
Increased information acquisition and transmission	SCHEER, P. C.
as a condition for the further development of energy economy structures	The SPS concept - An overview of status and outlook p0617 A80-48353
p0575 A80-50826 . SCH#URE, H. H.	SCHWUTTER, G. B. Low cost crystalline silicon
Applications of DOE-1 to passive solar heating of	p0600 A80-46703
connercial buildings - Preliminary results p0626 A80-52831	SCOPIELD, S. H.
SCHOBERT, H. H.	Comprehensive planning for passive solar architectural retrofit
Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed	[AC-A088660] · p0659 880-33907 SCOLA, R.
coal gasification	Energy from wood waste - A case study
[GFETC/BI-80/2] p0695 B80-29507 SCHOCE, B. W.	p0670 A80-47594 SCOTT-MORCK, J. A.
EBIC and capacitance measurements on Cu25-CdS solar cells - Stability problems	The applicability of DOE solar cell and array technology to space power
p0603 A80-46725	.p0613 A80-48206
SCHOCE, HW. Integrated Cu2S-CdS thin film solar cell generator	SCOTT, B. D. An overview of BASA's participation in the
p0606 A80-46770 SCHOCK, H. R.	nation's energy program p0625 A80-51950
The long-term effects of trace elements emitted by	SCOTT, B. J.
energy conversion of lignite coal [PB80-168867] p0578 M80-28958	Ocean engineering developments for OTEC 10/40 MW spar platforms
The long-term effects of trace elements emitted by	p0740 180-53686
energy conversion of lignite coal. Volume 2: Technical appendices	SCOTT, T. B. Haterials for coal liquefaction
[PB80-168875] p0579 880-28960	[ISE-246] p0690 H80-28549
SCHORMENDERGER, B. J. Anatomy of regional solid waste resource recovery	SCEOSATI, B. The lithium-sulfuryl chloride battery - Discharge
projects p0574 180-49939	behaviour p0772 A80-48770
SCHOBHPELD, D. E.	SEELIGEE, J.
Effects of thermal annealing on the deep-level defects and I-V characteristics of 200 keV	The CO2 problem from the viewpoint of geoecology and energy economy
proton irradiated AlGaAs-GaAs solar cells p0613 A80-48204	p0575 A80-50822
\$40704-00704	SECRE, S. B. On fusion alpha-particle heating of plasma below
	ignition

SEIBBET, B.		SHAVIV, E.	•	
Photoelectrochemical conversion us: reaction-centre electrodes		Energy conservation and solar houses		A80-50941
Biological solar cell	p0596 A80-45504	SHAW, D.  A new method of efficient heat trans	fer and	1 .
[SERI/TP-623-656] SRIDENSTICKER, R. G.	p0639 N80-29893	storage at very high temperatures	p0762	A80-48180
Silicon web process development [NASA-CR-163386] SEIREL, G. R.	p0631 880-28864	SHAW, I. E.  A low cost solar simulator for testi photovoltaic terrestrial solar pow		is and
Rapporteur report: MHD electric p	ower plants p0743 N80-29862	nodules	•	
[HASA-TH-81554] SELBACH, HJ. The influence of contact pressure		SBAU, B. P. Selenium heterostructure solar cells	₹ ,	A80-46738
performance of supported gas dif electrodes in alkaline H2-02-fue	fusion '			A80-46259
	p0739 A80-51459	SHEARRE, D. H. Theory of reverse combustion along f	issures	s in
SELP, S. 1. Study of the insulating wall bound	ary layer in a	fuel which gasifies at depth	p0675	A80-48341
Faraday MHD generator SELLES, L.	p0722 A80-47763	SHRAPR, J. A.  Hydration of 'spent' limestone and dental common c		
Engineering studies on the optimiz				A80-48172
collection subsystem of A I HW p		SHELBY, J. B. Properties of a solar alumina-borosi	licate	sheet
SELVAGE, R. B. G.	p0609 A80-46794	glass [SBRI/TP-334-565]	p0641	N80-30530
Sizing procedure and economic opti- methodology for seasonal storage		SERLION, E. M. Aviation turbine fuels, 1979	_	
SELVAN, A. H.	A80-46570	[DOB/BETC-PPS-80/2] SHERATTE, H. B.	p0703	B80-31627
A study of the gaseous and particum in the environment of a thermal		Cleaning agents and techniques for c solar collectors	oncenti	cating
project area	p0570 A80-46150		p0659	M80-33911
SEMLER, J. H. Formation and control of fuel-nitr	ogen pollutants	Thermoelectric MHD with walls parall magnetic field	el to t	the
in catalytic combustion of coal- [PE-2762-8]	derived gases p0577 180-28557	SHERICK, J. H.	p0739	A80-52971
SERRE, H. J. Comparative assessment of environm	**	Component Development and Integration description and status report	n Paci	lity - A
issues associated with the Satel System (SPS) and alternative tec	lite Power	SHERIDAY, D.	p0723	A80-48187
[DOB/ER-0055] SERVIDORI, M.	p0581 #80-30915	Shift conversion and methanation in gasification: Bench-scale evaluat		a
Effect of laser irradiation on the of implanted layers for silicon		sulfur resistant catalyst [FE-3240-T4]		N80-28561
SESHAD, K.	p0602 A80-46711	Shift conversion and methanation in gasification: Bench-scale evaluat	coal	
Research on Cu sub x S/(cd, Zn)S p solar energy converters	•	sulfur resistant catalyst [FE-3240-T5]	p0696	N80-29509
[LBL-10791] SETH, M.	p0654 B80-32927	SHERFIR, H. Liquid-phase methanol		
Liquid fuels from biomass: Cataly conditions	sts and reaction	[EPRI-AF-1291] SHERWOOD, W. G.	p0692	N80-28567
[LBL-9789] SEVERSON, D.	p0705 H80-31646	U.S. Department of Energy ocean wave currents energy conversion program		
Chemistry of lignite liquefaction [PB-2211-11]	p0704 N80-31642	SHETH, P. R.		A80-53678
SEWARD, J. S. Design of 40-MW grazing and moored		Closed cycle HHD power plant and ret optimization application	rofit	
pilot/demonstration plants	p0727 A80-48348	SHIBLDS, K. J.	p0717	A80-44231
SPRIE, A. A. A stochastic model for predicting	solar system	Research and evaluation of biomass resources/conversion/utilization s	ystems	
performance	p0621 A80-48921	(market/experimental analysis for a data base for a fuels from bioms	ass mode	e <b>l)</b>
SHAHERE, K. Oxidation of electrodeposited blac	k chrome	[DOE/ET-20611/11] SHIE, S. S.	p0700	N80-30552
selective solar absorber films [SAND-80-1045C]	p0656 N80-32953	Upgrading of coal liquids for use as generation fuels	-	
SHANNOH, L. Thermal energy storage systems usi	ng fluidized bed	[EPRI-AF-1225] SHIMADA, K.	p0699	80-30547
heat exchangers [NASA-CH-159868]	p0775 N80-28866	Heat flux at the thermionic collector	p0732	A80-48477
SHANNON, L. J. Study of thermal energy storage us.	ing fluidized	SHIMODAINA, M. Performance of the recently develope	ed Ni-Ca	l cells
bed heat exchangers	p0764 A80-48240	for the RTS-III batteries		A80-48399
SHAPIRA, H. B. Passive solar heating and natural	cooling of an	SHIMOTAKE, H. Cycle life studies of Lial/PeS cells	asing	PN felt
earth-integrated design [CONF-800449-1]	p0638 #80-29884	separators		A80-48189
SHARMA, A. Computer aided optimal design of c	ompressed air	Development of a tubular lithium-iro		lde cell 180-48192

p0761 A80-45626

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SHIPPEY, E. D.	SINON, M.
Development of a compressed air energy storage power generation plant - The PEPCO demonstration	Solar cells with concentrating collectors and
power generation plant - The PEPCO demonstration	integrated heat use system
plant study	p0604 180-46742
p0767 A80-48338	SIMONOY, A. A.
SHIRATORI, R.	Matching of a radioisotopic thermoelectric
Rotating strength of laminated composite discs	generator and an energy accumulator
p0762_A80-47454	p0720 A80-46599
SHIRARIAN, B. H.	SIMONS, S.
High-temperature fusion blanket for a synthetic	The photoklystron
fuel plant	p0623 A80-50956
p0663 A80-48451	SIMPSON, C. A.
SHIROGAMI, T.	Upgrading of coal liquids for use as power
Performance of the recently developed Ni-Cd cells	generation fuels [EPRI-AP-1225] p0699 N80-30547
for the ETS-III tatteries	[EPRI-AF-1225] p0699 N80-30547
p0769 A80-48399	T SIHAU, J. H.
SHORBAKRE, A. P.	Bean wind forces on parabolic-trough solar
Properties of a solar alumina-borosilicate sheet	collectors
qlass ·	collectors [SAND-80-7023] p0650 M80-32790
[SBEI/TP-334-565] p0641 N80-30530	SINDBLAR, L. B.
SAULUPUV. V. H.	Research on Cu sub x 5/1cd. Zui5 Dhotovoltaic
Metallic thermoelectric materials in solar	solar energy converters
thermoelectric generators	[LBL-10791] p0654 B80-32927
p0610 A80-47152	SINGE, H. P.
COMPACUITED AS WE	
Development of a bipolar Zn/Br2 battery	· difference technique
p0767 180-48369	[ASME PAPER 80-HT-107] p0612 A80-48036
p0767 A80-48369	21868 8*
Note on the condensation of the vapor phase above	KCONOMIC TEGNITEMENTS FOR NEW MATERIALS FOR SOLAR
a melt of iron oxide in a solar parabolic	photovoltaic cells
concentrator	p0596 A80-45317
p0611 A80-47664	Short circuit current in indium tim oxide/silicon solar cells
SIDIR, S. H.	solar cells
Cycles till failure of silver-zinc cells with	p0622 A80-50752
cycles till failure of silver-zinc cells with competing failure modes - Preliminary data	SINGE, R. H.
analysis p0761 A80-46414 SIBG, R. P.	carbonate fuel cells p0721 A80-47143
	SINGH, S. P.
liquefaction	Thermodynamic analysis of coal gasification
p0688 A80-53274	processes
SIPPRET, P.	p0686 A80-51210
Ion implanted solar cells from EFG silicon ribbons	p0686 A80-51210
p0601 A80-46705	solar energy activization by carbanion procolisis
Improvement of phosphorus diffused silicon solar cells by laser treatment p0606 A80-46763	p0625 A80-51680
cells by laser treatment	SIPES, T.
p0606 A80-46763	Environmental assessment report: Wellman-Galusha
210UAP I. N.	low-Btu gasification systems
Simulation and evaluation of latent heat thermal	low-Btu gasification systems [PB80-190796] p0589 #80-32995
energy storage heat pump systems	SIELDURIA de De
p0771 A80-48478	Coplanar back contacts for thin silicon solar cells
SIRRRUS, B.	[MASA-CR-159811] p0630 N80-28860
An emissometer with high accuracy for determination of the total hemispherical	SIRBN, G.
determination of the total nemispherical	Wood fuel production experiments in Sweden
emittance of surfaces p0621 A80-48547	p0687 A80-52854
puezi 880-46347	SIRTL, R.
SILAPABAHIBHG, K.	Technology and economics of starting materials for
The utilisation of oil shale and lignite as low	low-cost silicon solar cells
grade fuels in a cyclone furnace	p0600 180-46698
p0685 A80-50963	SISTIBO, A. J.
Characterization of open-cycle coal-fired #HD	Comparison of use of Hottel chart and the zone method for radiative heat transfer in our open
Characterization of open-cycle, coal-fired MHD generators	cycle MBD radiant boiler
generators [ABI-BP-43] p0750 H80-31936	[ASME PAPES 80-HT-44] p0722 A80-48022
SILVERMAN, J.	SITEK, G. B.
The CS/R advanced SNG hydrogasification process	Energy/Environment 4: Proceedings of the Bational
p0674 A80-48292	Conference on the Interagency Energy/Environment
SIM, J. W.	R and D Program
Testing of sintered LiAlO2 structures in molten	[PB80-177942] p0581 N80-29928
carbonate fuel cells	SIVASEGARAN, S.
p0721 A80-47143	Transient behaviour of wind energy systems
SIMINSKI, V. J.	p0734 A80-48521
Miniplant and bench studies of pressurized	Transient thermal behaviour of solar ponds
fluidized-bed coal combustion	p0623 A80-50962
[PB80-188121] p0712 N80-32599	SKIHUBB, B. W.
SIMRIPS, B. B.	Approach to steady-state solvent composition in
Energy from MSW - The industrial market	the SRC-I coal liquefaction process
p0670 A80-47588	p0676 A80-48382
SIMMORS, D. R.	SKOTCH, M. B.
Energy storage as heat-of-fusion in containerized	Silicon web process development
salts. Report on energy storage boiler tank	[NASA-CR-163386] p0631 N80-28864
[AD-A087753] p0777 M80-32862	SLACE, L. B.
SIMON, P. P.	CdSiAs2 thin films for solar cell applications
Spectral effects on direct-insolation absorptance	[COM/ET-23007/1] F0653 N80-32919
of five collector coatings	SLAGG, B.
[ASME PAPER 79-HT-18] . p0597 A80-45722	Vapor cloud explosion studies in the United States
	p0590 N80-33595

SLATER. M. H. SHITH. H. D. Molten salt coal gasification process development Otilization of low temperature insulators and unit seals in thermionic converters [SAB-1429-52] p0700 M80-30554 Molten salt coal gasification process development D0732 A80-48474 SMITH, M. J. Steam engine analysis [PE-8917-2] SAN-1429-56 1 p07C3 N80-31631 p0743 N80-29741 SLEHADDES, A. J.

Line-focus solar central power system, phase 1.

Subsystem experiment: Beceiver heat transfer
[DOZ/BT-20550/1] p0655 #80-SMITH, No. L.

The combustion engineering approach to municipal solid waste energy recovery p0655 #80-32945 D0681 A80-49959 SLIWINSKI, B. J. SMITH, P. J. Investigation of methods to predict thermal One-dimensional model for pulverized coal stratification and its effect on sclar energy combustion and gasification system performance [AD-A086051] p0669 A80-45322 Mixing and gasification of coal in entrained flow D0636 N80-29864 SLOWLEY, J. systems. Volume 2: User's manual for a computer program for 1-dimensional coal Investigation of a Philips MP 1002 CA Stirling combustion or gasification (1-DICOG)
[FE-2666-F-VOL-2] engine p0734 A80-48499 p0706 N80-31656 SMAIL H. Photovoltaic institutional issues study [SAND-79-7054] p0 Chemical Energy Storage for Solar Thermal Electric D0584 N80-31950 Conversion SHALL T. B.
Low-cost flywheel demonstration program p0763 A80-48195 Chemical energy storage for solar thermal conversion [SAND-79-8198] p0652 N80-32889 [DOR/ET-26931/T1] p0: Low-cost flywheel demonstration program [CONS-5085-T2] p0: p0778 N80-32897 SMITH, R. W. : Amorphous thin films for solar-cell applications p0780 880-33909 SMEALLIE, P. H. [DOB/ET-21074/4] p0653 N80-32921 Capital formation for small wind energy conversion system manufacturers: A guide to methods and SMITH, T. P. Large-scale electrical energy storage p0761 A80-44241 sources [SBRI/TR-98298-1] SHRKEBS, G. E.
Study of a hydro-photovoltaic plant for peak power
generation in central and northern European Assessment of Peruvian biofuel resources and alternatives [ANL/EES/TH-86] SMITHBICK, J. J. countries Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells D0605 A80-46746 Distributed series resistance in photovoltaic p0766 A80-48329 SHOOT, L. D.
One-dimensional model for pulverized coal devices - Intensity and loading effects p0624 A80-51118 combustion and gasification SMIRHOV. V. P. Magnetic-pressure acceleration of cylindrical p0669 A80-45322 liners by the pulse generators for relativistic Mixing and gasification of coal in entrained flow electron beams systems. Volume 2: User's manual for a computer program for 1-dimensional coal p0736 180-49098 · combustion or gasification (1-DICOG)
[FE-2666-P-VOL-2] Advanced combustion systems for stationary gas turbine engines. Volume 2: Bench scale D0706 N80-31656 B. B. SMYE, B. B. Methods of improving limestone utilization in evaluation [ PB80-175607 ] fluidized-bed combustion Advanced combustion systems for stationary gas turbine engines. Volume 4: Combustor verification testing, addendum D0672 A80-48170 SMITH, R. R. Development of the high temperature air heater for [PB80-179849] p0698 N80-30313 open cycle MHD SHITH, G. A.
Dual curvature acoustically damped concentrating p0724 A80-48224 · SEELL, G. J.
Past fluid bed coal gasification in a process collector [DOE/CS-34196/T1] p0647 H80-31921 development unit SHITH, G. B. p0672 A80-48245 Solar selective black cobalt - Preparation, SEIDER, H. B.
Peasibility studies of spoiler and aileron control structure, and thermal stability P0609 A80-46933 systems for large horizontal-axis wind turbines p0727 A80-48318 SOLHAR, P. J.
The 100-kmp photovoltaic power system at Matural
Bridges National Monument
p0615 A80-4 Hydration of 'spent' limestone and dolomite to enhance sulfation in fluidized-bed combustion p0672 180-48172 SHITE, I. B.
Thermal energy storage using saturated salt p0615 A80-48227 SOLONON, J. solutions A study of industrial hydrogen and syngas supply P0774 A80-51125 systems [ HASA-CR- 163523] SMITH, J. L., JR.

Performance loss due to transient heat transfer in p0666 B80-31624 SCRATÈIA, U. A. the cylinders of Stirling engines Development of polyimide materials for use in solar energy systems [DOE/CS-35305/T2] p0730 A80-48410 p0636 N80-29870 SOREBSEN, G. L.
The 1980 technology status of the Dynamic Isotope Experiments on H2-02 MHD power generation p0717 A80-44239 Power System p0725 A80-48255 Refuse/sludge/hazardous waste co-disposal with SOUBY, B. energy recovery Chemistry of lignite liquefaction [FE-2211-11] New method to determine the independent shear moduli of transversely isotropic materials DO704 #80-31642 SOUZA, C. J. [CONF-800575-1] p0712 N80-32796 Large area flexible solar array design for Space . Shuttle application

D0615 A80-48214

p0675 A80-48340

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Interface/Institutional Insees. Volume 1: 8 milestrates of aircraft-type fuels [18.58-0-10-10-10] posses 80-3053 [18.58-7-10-10-10-10-10-10-10-10-10-10-10-10-10-		
Autologation characteristics of aircraft-type feels [RFP-3014-101-1] pol78 80-3053 [RFF-3014-101-1] pol78 80-3053 [RFF-3014-101-1] pol78 80-3053 [RFF-3014-101-1] pol78 80-3054 [RFF-3014-101-1] pol78 80-3055 [RFF-3014-101-1] pol78 80-3056 [RFF-3014-101-1] pol78 80-3057 [RFF-3014-1]	[SAND-80-1045C] p0656 N80-32953	
FARMELLES, A. B.  The technical and economic aspects of brown coal registration of sharp boundary heaters in possis 800-1985  SPHINGER, B.  The technical and economic aspects of brown coal registration of sharp boundary heaters in possis 800-1987  SPHINGER, B.  The technical and economic aspects of brown coal registration of sharp boundary heaters in pulsiple plate to a possis 800-1989  SPHINGER, B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  SPHINGER, A. B.  Aliford storage for solar central receiver power actions  (FRE-296-43)  Power solar solar power solar s		and D requirements [RPP-3014-VOL-11 p0747 M80-3094]
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passification screening test results p0707 180-31586 Photovoltaic applications definition and photovoltaic agricultations and photovoltaic agricultations definition and photovoltaic agricultations and photovoltaic agricultations definition and photovoltaic agricultations of vind loads on solar collectors.  [3181-79-7018/37] p0623 880-28973  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  The fate and effect out crude oil spilled on p0633 880-28937  SPARROW, F. 8.  Alifythough F. 8.  SPARROW, F. 8.  Alifythough F. 8.  Alifythough F. 8.  SPARROW, F. 8.  SPARROW, F. 8.  Alifythough F. 8.  SPARROW, F. 8.  SPARROW, F. 8.		
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and botton of collector [P880-18755]  SPARMOW, R. B.  Generatic persors terrain interior Alaska [P860-187305]  P0505 880-3198  SPARMOW, R. B.  Generatic persors terrain interior Alaska [P860-187305]  SPARMOW, R. B.  Convective-restitive interaction in a parallel  solar collectors  p0598 880-46349  SPEICE, R.  The technical and economic aspects of brown coal  refinement  p0686 880-51498  SPEICER, R. L.  Bifurcation of sharp boundary beta=1 sultipole equilibria  spiriture, T. B.  Alirrock storage for solar central receiver power stations  SPINISER, T. B.  Decelopment and application of analytical  Independent on the program and applications  p0613 880-4828  Fuel cell applied research: Electrocatalysis and anterials  [RBL-51032]  Fuel cells for electric utility and transportation applications  p0772 880-48282  Fuel cell applied research: Electrocatalysis and anterials  [RBL-51072]  p0774 880-29825  Fuel cells for electric utility and transportation applications  p0772 880-29825  Fuel cells for electric utility and transportation applications  p0774 880-29825  Fuel cells for electric utility and transportation applications  p0774 880-29825  Fuel cells for electric utility and transportation applications  p0774 880-29825  STANDERCK, S.  STANDERCK, S.  STANDERCK, S.  Bickel hydrogen battery advanced development program status report  p0770 880-48439  STANDERCK, S.  Rickel hydrogen battery for a spacecraft power subnystes  p0770 880-48439  STANDERCK, S.  Rickel hydrogen battery for a spacecraft power subnystes  p0770 880-48439  STANDERCK, S.  Rickel hydrogen battery for a spacecraft power subnystes  p0770 880-48439  STANDERCK, S.  Rickel hydrogen battery for a spacecraft power subnystes  p0770 880-48439  STANDERCK, S.  Rickel hydrogen battery for a spacecraft power subnystes  p0770 880-48439  STANDERCK, S.  Rickel hydrogen battery for a spacecraft power subnystes  p0770 880-48439  STANDERCK, S.  Rickel hydrogen battery for a spacecraft power subnystes  p0770 880-48439  STANDERCK, S.  Rickel hydrogen battery for a spac		
SPRINGER, F. B.  The fate and effects of crude oil spilled on subarctic permafrost terrain in interior Maska posss \$80-31984  SPRINGER, F. B.  \$PARROW, F. B.  \$PARROW, F. Phylication to air-operated solar callectors  \$PARROW, F. P.  \$PARR	and bottom of collector	STRIB, T. R.
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SPHICE, R.  The technical and economic aspects of brown coal refinement  SPECER, R. L.  Biffercation of sharp boundary beta-1 multipole equilibria  p0736 A80-49074  SPRINGER, R. L.  SPRINGER, R. L.  SPRINGER, R. L.  Biffercation of sharp boundary beta-1 multipole equilibria  p0736 A80-49074  SPRINGER, R. L.  SPRINGER, R. L.  SPRINGER, R. S.  Airrock storage for solar central receiver power stations  p0613 A80-48195  SQUERES, A. R.  Development and application of analytical tiquefaction (FZP-266-744)  p0695 880-29472  SRIFINASAR, S.  Improved alkaline bydrogen/air fuel cells for transportation applications  p0726 A80-48282  Fuel cell applied research: Electrocatalysis and materials  [BNL-51072]  [BN		
The technical and econosic aspects of brown coal refinement points and refinement points and points are possible points. SPENCER, R. I.  Bifurcation of sharp boundary beta=1 multipole equilibria po736 A80-49074  SPRINGER, T. B.  SPRINGER, T. B.  Air/rock storage for solar central receiver power stations  SQUIRES, A. B.  Development and application of analytical techniques to chemistry of donor solvent liquefaction [FE-2696-T4]  SRIBINGER, S.  Improved alkaline hydrogen/air fuel cells for transportation applications  [BMI-2782]  Fuel cell applied research: Electrocatalysis and anterials  [BMI-2782]  Fuel cell applied research: Electrocatalysis and applications  [BMI-2782]  Fuel cells for electric utility and transportation applications  [BMI-2782]  SRIBBAR, E.  Honitoring of the performance of a solar heated and cooled apartment building [BMI-2782]  SRIBBAR, E.  STADBICK, S. J.  The 20 percent solar energy goal: Is there a plan to attain it?  STADBICK, S. J.  Hickel hydrogen battery advanced development program status report  BO770 A80-48495  STADBICK, S. J.  Hickel hydrogen battery for a spacecraft power subsystes  PO770 A80-48490  STADBICK, S. J.  FABBICK, B.  Coal gasification in fluidized bed combustion:  The Elash hydropyrolysis of lignite and sub-bituinous coals to both liquid and gaseous hydrocaton broducts in bytoic cycles and sub-bituinious coals to both liquid and gaseous hydrocaton products  po679 A80-49074  Papilication of the fusion reactor to the electrochesical hybrid cycles and electrolysis for hydrogen production from water po664 A80-5146  [BMI-27782]  STHATUSAND.  STADBICK, S. J.  The 20 percent solar energy goal: Is there a plan to attain it?  BO770 A80-48495  STADBICK, S. J.  The 20 percent solar energy goal: Is there a plan to attain it?  BO770 A80-48495  STADBICK, S. J.  The 20 percent solar energy goal: Is there a plan to attain it?  BO770 A80-48495  STADBICK, S. J.  The 20 percent solar energy goal: Is there a plan to attain it?  BO770 A80-48495  STADBICK, S. J.  Adapting products and sub		
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SPENCER, R. I.  Bifurcation of sharp boundary beta=1 multipole equilibria  p0736 A80-49074  SPRINGER, T. B. Air/rock storage for solar central receiver power stations  p0613 A80-48196  SQUIRRS, A. M. Development and application of analytical techniques to chemistry of donor solvent liquefaction [FF-2696-14]  SRINIVANSM, S. Improved alkaline hydrogen/air fuel cells for transportation applications  p0726 A80-48282  Fuel cell applied research: Electrocatalysis and materials [BBL-27452]  Fuel cells applied research: Electrocatalysis and materials [BBL-27452]  Fuel cells for electric utility and transportation applications  SCHUBAR, E.  Honitoring of the performance of a solar heated and cooled apartent huilding [DSZ-5235-T1]  STAATS, E. B. The 20 percent solar energy goal: Is there a plan to attain it?  STADDICK, S. J. Hickel hydrogen battery advanced development program status report  p0770 A80-48495  STADDICK, S. J. Hickel hydrogen battery for a spacecraft power subsystem  p0770 A80-48490  STADDICK, S. J.  Coal gasification in fluidized bed combustion:  swhitch and prications applications p0744 R80-29885 [BBL-27452]  STADDICK, S. J.  EXPERSION CREATER (bytogen production via electrochemical hybrid cycles and electrolist for hydrogen production via the electrochemical-electrochemical hybrid cycles and electrolist for hydrogen production via the electrochemical-electrochemical hybrid cycles and electrolists for hydrogen production via the electrochemical-electrochemical hybrid cycles and electrolists for hydrogen production via the electrochemical-electrochemical hybrid cycles and electrolists for hydrogen production via the electrochemical-electrochemical hybrid cycles and electrolists for hydrogen production via the electrochemical hybrid cycles and electrolists for hydrogen production via the electrochemical hybrid cycles and electrolists for hydrogen production via the electrochemical-electrochemical-hybrid cycles and electrolists for hydrogen production via the electrochemical melectrochemical hybrid cycles an		
SHINGER, T. H.  Air/rock storage for solar central receiver power stations  PO613 A80-48196  SQUIRES, A. H.  Development and application of analytical techniques to chemistry of donor solvent techniques to chemistry of donor solvent liquefaction [FE-2696-14] p0695 N80-29472  SRIKIVASAR, S.  Improved alkaline hydrogen/air fuel cells for transportation applications  [BNL-51073] p074 A80-48282  Fuel cell applied research: Electrocatalysis and materials  [BNL-51073] p0744 N80-29825  Fuel cells for electric utility and transportation applications  [BNL-51073] p0744 N80-29825  Fuel cells applied research: Electrocatalysis and materials  [BNL-51073] p0744 N80-29825  Fuel cells applied research: Electrocatalysis and materials  [BNL-51073] p0744 N80-29825  Fuel cells for electric utility and transportation applications  Fuel cells for electric utility and transportation applications  [BNL-51073] p0744 N80-39937  SRUBAR L.  SRUBAR	p0686 A80-51498	
SPRINGER, T. B.  SPRINGER, T. B.  SPRINGER, T. B.  Air/rock storage for solar central receiver power stations  p0613 A80-48196  SQUIRES, A. B.  Development and application of analytical techniques to chesistry of donor solvent liquefaction		
SPRINGER, T. B.  Air/rock storage for solar central receiver power stations  \$ p0613 A80-48196  SQUIRES, A. B.  Development and application of analytical techniques to chemistry of donor solvent liquefaction [PE-2696-T4]  SETINIVASH, S.  Improved alkaline hydrogen/air fuel cells for transportation applications  [BNI-51073]  Puel cell applied research: Electrocatalysis and materials  [BNI-51072]  Puel cell applied research: Electrocatalysis and materials  [BNI-51072]  Puel cells for electric utility and transportation applications  [BNI-77852]  SEUBAR, R. L.  Honitoring of the performance of a solar heated and cooled apartment building  [BSI-77852]  STADBLEK, S.  The 2D percent solar energy goal: Is there a plan to attain it?  [EMD-80-64]  STADBLEK, S.  Nickel hydrogen battery advanced development program status report  P0770 A80-4849  STADBLEK, S.  Nickel hydrogen battery for a spacecraft power subsystes  P0770 A80-4849  STADBLEK, S.  Coal gasification in fluidized bed combustion:  electrolysis for hydrogen production from water position reactors for hydrogen production via electrolysis gone about control technology for carbon dioride [DOE/BV-0079]  Pusion reactors for hydrogen production via electrolysis gone about in electrolysis gone alectrolysis gone electrolysis gone above posses posses of the full flow posses posses of the full plant product for a synthetic fuels  FRILLA, P. B.  The belictrolysis gone product ochloride electrolysis gone alectrolysis gone		
SQUIRES, A. B.  Development and application of analytical techniques to chemistry of donor solvent liquefaction [PE-2696-T4] p0695 N80-29472  SRINIVASH, S.  Improved alkaline hydrogen/air fuel cells for transportation applications p0726 A80-88282  Fuel cell applied research: Electrocatalysis and materials [BNL-51053] p0742 N80-28920 [PNL-51053] p0742 N80-29885 [PNL-51072] p0744 N80-29885 [PNL-7852] p0747 N80-39937  SRIBBA, B. L.  Honitoring of the performance of a solar heated and cooled apartment building [DSE-235-T1] p0638 N80-32913  STAINS, E. B.  The 2D percent solar energy goal: Is there a plan to attain it? [EM-0-64] p0638 N80-29880  STADBICK, S.  Nickel hydrogen battery advanced development program status report subsystes p0770 A80-4849  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystes p0770 A80-4849  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystes p0770 A80-4849  STADBICK, S. J.  Coal gasification in fluidized bed combustion:  P0613 A80-48495  Fusion reactors for hydrogen production via electrolysis [BNL-27782] p0667 N80-3255  Fusion: An energy source for synthetic fuels [PNE-1079] p0588 N80-3291  STRIBIAURR, L. C.  High-27782] p0742 N80-28920  STRIBIAURR, L. C.  High-27782] p0744 N80-28920  STRIBIAURR, L. C.  High-27782] p0744 N80-28920  STRIBIAURR, L. C.  High-27782] p0744 N80-29885  STRIBIAURR, L. C.  High-27782] p0743 A80-4849  STRIBIAURR, L. C.  High-27782] p0744 N80-29885  STRIBIAURR, L. C.  High-27782] p0744 N80-29885  STRIBIAURR, L. C.  High-27782] p0744 N80-29885  STRIBIAURR, L. C.  High-27782] p0748 N80-29885  STRIBIAUR		
Pusion reactors for hydrogen production via electrolysis.  SQUIRES, A. B.  Development and application of analytical techniques to chemistry of donor solvent liquefaction in fluidized bed combustion:  SRIBITURASH, S.  Improved alkaline hydrogen/air fuel cells for transportation applications  [BNL-51053] p0742 M80-28920  Puel cell applied research: Electrocatalysis and materials  [BNL-51053] p0742 M80-28920  Puel cell applied research: Electrocatalysis and materials  [BNL-51053] p0742 M80-28920  Puel cell applied research: Electrocatalysis and materials  [BNL-51052] p0744 M80-28920  Puel cells for electric utility and transportation applications  [BNL-71852] p0747 M80-30937  SRUBAR, R. L.  Honitoring of the performance of a solar heated and cooled apartment building [DSE-2355-T1] p0653 M80-32913  STABLES, R. B.  The 20 percent solar energy goal: Is there a plan to attain it?  [EMD-80-64] p0638 M80-29880  STADBICK, S. J.  Nickel hydrogen battery advanced development program status report po770 A80-48495  STABLE, R. A.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48494  STABLES, R. B.  Coal gasification in fluidized bed combustion:  Puel cell applied research: Electrocatalysis and naterials (BNL-27891] p0653 M80-2880  STABLER, R. B.  Frence call applied research: Electrocatalysis and naterials (BNL-27891) p0750 M80-36489  STABLER, R. B.  Ecological research: Electrocatalysis and naterials (BNL-27891) p0750 M80-38913  STABLER, R. B.  Frence call applied research: Electrocatalysis and naterials (BNL-27891) p0750 M80-38920  STABLER, R. B.  Frence call applied research: Electrocatalysis and naterials (BNL-27891) p0750 M80-38920  STABLER, R. B.  Frence call applied research: Electrocatalysis and naterials (BNL-27891) p0653 M80-29800  STABLE, R. B.  Frence call applied research: Electrocatalysis and naterials (BNL-27891) p0653 M80-32913  STABLER, R. B.  Frence call applied research: Electrocatalysis and naterials (BNL-27891) p0653 M80-38920  STABLE, R. B.  Frence call applied research: Electrocat		
Development and application of analytical techniques to chemistry of donor solvent liquefaction [FE-2696-74]  SERINIVANAP, S. Improved alkaline hydrogen/air fuel cells for transportation applications  Fuel cell applied research: Electrocatalysis and materials [BNL-51053] Puel cell applied research: Electrocatalysis and materials [BNL-51072] Puel cells for electric utility and transportation applications [BNL-27452] STUBAR, E.  Monitoring of the performance of a solar heated and cooled apartment building [DSR-5235-T1] STATAS, E. B.  The 20 percent solar energy goal: Is there a plan to attain it? [EMD-80-60] STADBICK, S.  Nickel hydrogen battery advanced development program status report STADBICK, S.  Nickel hydrogen battery for a spacecraft power subsystem  DO770 A80-4849  STADBICK, S.  Coal gasification in fluidized bed combustion:  EBBL-27782] P0657 N80-29472  Environmental control technology for carbon dioxide [DOZ/EV-0079] Pusion: An energy source for synthetic fuels [BNL-27891] STRICK - L.  Eigh-temperature fusion blanket for a synthetic fuel plant  TRACT - A small fusion reactor based on near-term engineering  P0774 N80-29820  TRACT - A small fusion reactor based on near-term engineering  P0774 N80-29855  TRACT - A small fusion reactor based on near-term engineering  P0773 A80-484920  STERLA, P. B.  The applicability of DOE solar cell and array technology to space power  STERBERG, V. I.  Chemistry of liquite liquefaction [FE-2-211-11] STERBERG, V. I.  Chemistry of liquite liquefaction [FE-2-211-1	stations	
Development and application of analytical techniques to chemistry of donor solvent liquefaction [PE-2696-T4] p0588 p800-29472 p0588 p800-32972 possess posses		
techniques to chemistry of donor solvent liquefaction [FE-2696-T4] p0695 N80-29472  SEMINIANA, S.  Improved alkaline hydrogen/air fuel cells for transportation applications  Puel cell applied research: Electrocatalysis and materials [BNL-51053] p0742 N80-28920 Puel cell applied research: Electrocatalysis and materials [BNL-51072] p0744 N80-29885 Fuel cells for electric utility and transportation applications [BNL-27891] STEMLA, P. BA The proved alkaline hydrogen bettery for a spacecraft power subsystem  STADBICK, S. J. Nickel hydrogen battery for a spacecraft power subsystem  STADECK, B. Coal gasification in fluidized bed combustion:  [FE-2696-T4] p0695 N80-29472  [FE-2696-T4] p0695 N80-29472  [FILL 27891] STRINHAUR, L. C. Bigh-temperature fusion blanket for a synthetic fuels [BNL-7491] p0663 A80-48495  STELLA, P. BA The applications p0744 N80-29885 [BNL-27891] p0744 N80-29885  FRACT - A small fusion reactor based on near-term engineering p0703 A80-48495  STELLA, P. BA The applications p0744 N80-29885 [FE-2231-T1] p0653 N80-32913  STELLA, P. BA The applications p0748 N80-29880  STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3195  STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STERNERG, V. I. Chemistry of liquite liquefaction [FE-2211-11] p0704 N80-3164: STE		
[FF-2696-T4] p0665 N80-29472 SRHINVASM, S. Improved alkaline hydrogen/air fuel cells for transportation applications  Fuel cell applied research: Electrocatalysis and materials  [BNL-51053] p0742 N80-28920 Fuel cell applied research: Electrocatalysis and materials  [BNL-51072] p0744 N80-29885 Fuel cells for electric utility and transportation applications  [BNL-27452] p0747 N80-30937 SRUBAR, B. L.  Honitoring of the performance of a solar heated and cooled apartment building  [DSE-5235-T1] p0653 N80-32913 STANDICK, S.  Mickel hydrogen battery advanced development program status report  P0770 A80-48493 STANDICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  STANDICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  STANDICK, S.  P0770 A80-48494 STARGE, B.  Coal gasification in fluidized bed combustion:  [BRL-27891] SFRIBADER, L. C.  Bigh-temperature fusion blanket for a synthetic fuel plant  fuel plant  FARCT - A small fusion reactor based on near-term engineering  P0733 A80-4849  STELLA, P. M.  The application function of DOB solar cell and array technology to space power  Thomographication function of DOB solar cell and array technology to space power  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of lignite liquefaction  [FR-2211-11] p0704 N80-3164  STERBERG, V. L.  Chemistry of	techniques to chemistry of donor solvent	[DOE/EV-0079] p0588 N80-3297
SRINFASH, S. Improved alkaline hydrogen/air fuel cells for transportation applications  Fuel cell applied research: Electrocatalysis and materials [BNL-51053] p0742 N80-28920 Fuel cell applied research: Electrocatalysis and materials [BNL-51072] p0744 N80-29885 Fuel cells for electric utility and transportation applications [BNL-27452] p0747 N80-30937 SRUBAR, E. L.  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-32913 STANTS, E. B. The 20 percent solar energy goal: Is there a plan to attain it? [EMD-80-64] p0638 N80-29880 STADBICK, S. Nickel hydrogen battery advanced development program status report program status report po770 A80-48499 STADBICK, S. J. Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440 STABEC, H. Coal gasification in fluidized bed combustion:  STEPHES, D. R. Eighlights of the LLL Hoe Creek No. 3 underground coal gasification experiment		
Fuel cell applied research: Electrocatalysis and materials [BNL-51053] p0742 N80-28920 Puel cell applied research: Electrocatalysis and materials [BNL-51072] p0742 N80-29885 Puel cells for electric utility and transportation applications [BNL-71452] p0747 N80-30937 SRUBAR, E. L.  Honitoring of the performance of a solar heated and cooled apartment building [DSZ-5235-T1] p0653 N80-32913 STANATS, E. B. The 20 percent solar energy goal: Is there a plan to attain it? [EMD-80-64] p0638 N80-29880 STADBICK, S. J. Nickel hydrogen battery advanced development program status report p0770 A80-48499 STADBICK, S. J. Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440 STADBICK, S. J. Coal gasification in fluidized bed combustion:  fuel plant p0663 A80-4849  TRACT - A small fusion reactor based on near-term engineering  p0733 A80-4849  STELLA, P. M. The applicability of DOE solar cell and array technology to space power  p0613 A80-4820  STENBERG, V. I. Chemistry of lignite liquefaction [F2-2211-11] p0704 N80-3164  STENBERG, R. L.  Hethodology for the comparative assessment of the Satellite Power System (SFS) and alternative technologies  [BNS-CR-163049] p0750 N80-3195  STEPHEN, R. L.  Adapting evident energy to produce ethanol for automotive fuel  STEPHEN, R. L.  Performance monitoring of low energy house, Macciesfield p0775 A80-5094  STEPHENS, D. B.  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  p0670 A80-4660	SRINIVASAN, S.	STRIBBAUER, L. C.
Puel cell applied research: Electrocatalysis and materials [BNI-51053] Puel cell applied research: Electrocatalysis and materials [BNI-51072] Puel cell applied research: Electrocatalysis and materials [BNI-51072] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells for electric utility and transportation applications [BNI-27452] Puel cells applied research: Electrocatalysis and engineering Puel cells for electric utility and transportation applications [BNI-27452] Puel cells applied research: Electrocatalysis and engineering Puel cells for electric utility and transportation Puel cells for electric utility and transportation applications [BNI-27452] Puel cells applied research: Electrocatalysis and engineering Puel cells for electric utility and transportation applications Puel cells for elect		
Fuel cell applied research: Electrocatalysis and materials  [BNL-51053] p0742 N80-28920 Puel cell applied research: Electrocatalysis and materials  [BNL-51072] p0744 N80-29885 Fuel cells for electric utility and transportation applications  [BNL-77452] p0747 N80-30937 SRUBAR, R. L.  Monitoring of the performance of a solar heated and cooled apartment building  [DSR-5235-T1] p0653 N80-32913 STANATS, E. B.  The 20 percent solar energy goal: Is there a plan to attain it?  [EMD-80-64] p0636 N80-29880 STADBICK, S.  Nickel hydrogen battery advanced development program status report program status report subsystem  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48493  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-4849  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48493  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48493  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subs		
Fuel cell applied research: Electrocatalysis and materials [BNL-51072] p0744 N80-29885 Fuel cells for electric utility and transportation applications [BNL-27452] p0747 N80-30937  SRUBBAR, B. L. Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-32913  STANTS, E. B. The 20 percent solar energy goal: Is there a plan to attain it? [EMD-80-64] p0638 N80-29880  STADBICK, S. Nickel hydrogen battery advanced development program status report  P0770 A80-48439  STADBICK, S. J. Nickel hydrogen battery for a spacecraft power subsystem  P0770 A80-48440  STARGE, B. Coal gasification in fluidized bed combustion:  STERERS, D. B. Bighlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  P0670 A80-46600		TRACT -A small fusion reactor based on near-term
Fuel cell applied research: Electrocatalysis and materials [BNL-51072] p0744 N80-29885 Fuel cells for electric utility and transportation applications [BNL-27452] p0747 N80-30937  SRUBAR, B. L. Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-32913  STAATS, E. B. The applicability of DOE solar cell and array technology to space power  [FE-2211-11] p06613 A80-48206  STENBERG, V. L. Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L. Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L. Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Adapting geothermal energy to produce ethanol for automotive fuel  STENBERG, V. L.  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Adapting geothermal energy to produce ethanol for automotive fuel  STENBERG, V. L.  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-211-11] p0704 N80-3164:  STENBERG, V. L.  Adapting geothermal energy to produce ethanol for automotive fuel  STENBERG, V. L.  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V. L.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STENBERG, V.		
The applicability of DOE solar cell and array technology to space power  Fuel cells for electric utility and transportation applications [BNL-27452] p0747 N80-30937  SRUBAR, R. L.  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-32913  STANTS, R. B.  The 20 percent solar energy goal: Is there a plan to attain it? [EMD-60-64] p0638 N80-29880  STADBICE, S.  Nickel hydrogen battery advanced development program status report p0770 A80-48439  STADBICE, S. J.  Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440  STABGE, H.  Coal gasification in fluidized bed combustion:  The applicability of DOE solar cell and array technology to space power technology to posice power power power power power posice power technology to posice power posice power power posice power power power posice power power posice power posice power power posice power posice power posice power posice power power posice power power posice power posice power power posice power posice power power posice power power posice power posice power posice power power posice power posice power power posice power posice power posice power posice power posice power power posice power posice power power posice po	Fuel cell applied research: Electrocatalysis and	STELLA, P. M.
Fuel cells for electric utility and transportation applications [BBL-27452] p0747 N80-30937  SRUBAR, R. L.  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-32913  STANTS, B. B.  The 20 percent solar energy goal: Is there a plan to attain it? [BMD-80-64] p0638 N80-29880  STADBICK, S. J.  Nickel hydrogen battery advanced development program status report p0770 A80-48439  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440  STARGE, B.  Coal gasification in fluidized bed combustion:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V. I.  Chemistry of lignite liquefaction [FE-2211-11] p0704 N80-3164:  STEMBERG, V	materials	
applications [BNL-27452] p0747 N80-30937  SRUBAR, R. L.  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-32913  STANTS, R. B.  The 20 percent solar energy goal: Is there a plan to attain it? [END-80-64] p0638 N80-29880  STADBICK, S.  Nickel hydrogen battery advanced development program status report program status report p0770 A80-48439  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440  STARGE, R.  Coal gasification in fluidized bed combustion:  STEPHENS, D. R.  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment p0670 A80-48600		
SRUBAR, R. L.  Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-32913  STANTS, R. B.  The 20 percent solar energy goal: Is there a plan to attain it? [END-80-64] p0638 N80-29880  STADBICK, S.  Nickel hydrogen battery advanced development program status report p0770 A80-48439  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440  STARGE, H.  Coal gasification in fluidized bed combustion: [FE-2211-11] p0704 N80-31642  STENEBJEH, R.  Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative stechnologies [NS3-CR-163049] p0750 N80-3195  STENEBLE, R. A.  Adapting geothermal energy to produce ethanol for automotive fuel p0723 A80-4818.  STEPHEN, P. R.  Performance monitoring of low energy house, Macciesfield p0575 A80-50946  STEPHENS, D. R.  Bighlights of the LLL Hoe Creek No. 3 underground coal gasification experiment p0670 A80-46606	. applications	
Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 N80-32913  STANTS, E. B.  The 20 percent solar energy goal: Is there a plan to attain it? [END-80-64] p0638 N80-29880  STADBICK, S.  Nickel hydrogen battery advanced development program status report p0770 A80-48439  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440  STARGE, B.  Coal gasification in fluidized bed combustion:  STANGE AND COAL GARDEN (SPS) and alternative technologies [NASA-CR-163049] p0750 N80-3195  STEPHEN, R.  Adapting geothermal energy to produce ethanol for automotive fuel  P0723 A80-4818.  STEPHEN, P. B.  Performance monitoring of low energy house, Macciesfield  STEPHENS, D. B.  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment		
[DSE-5235-T1] p0653 N80-32913  STANTS, B. B. The 20 percent solar energy goal: Is there a plan to attain it? [EMD-80-64] p0638 N80-29880  STADBICK, S. Nickel hydrogen battery advanced development program status report p0770 A80-48439  STADBICK, S. J. Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440  STARGE, B. Coal gasification in fluidized bed combustion:  STARGE STADBICK	monitoring of the performance of a solar heated	STENEBJEM, B.
STARTS, E. B.  The 20 percent solar energy goal: Is there a plan to attain it? [END-80-64] p0638 880-29880  STADNICK, S. Nickel hydrogen battery advanced development program status report p0770 A80-48439  STADNICK, S. J. Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440  STARGE, B. Coal gasification in fluidized bed combustion:  technologies [NASA-CR-163049] p0750 880-3195  STEPHEN, R. A. Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-4818. STEPHEN, P. B. Performance nomitoring of low energy house, Macclesfield  STEPHENS, D. B. Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment p0670 A80-46600		
The 20 percent solar energy goal: Is there a plan to attain it? [END-80-64] p0638 N80-29880  STADBICK, S.  Nickel hydrogen battery advanced development program status report p0770 A80-48439  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem p0770 A80-48440  STARGE, B.  Coal gasification in fluidized bed combustion:  [NASA-CR-163049] p0750 N80-3195  STEPBEL, R. A.  Adapting geothermal energy to produce ethanol for automotive fuel  p0723 A80-4818.  STEPBEN, P. B.  Performance monitoring of low energy house, Hacciesfield  STEPBENS, D. B.  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment		
[EHD-80-64] p0638 880-29880 Adapting geothermal energy to produce ethanol for automotive fuel  Nickel hydrogen battery advanced development program status report  P0770 860-48439  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  p0770 880-48440  STARGE, B.  Coal gasification in fluidized bed combustion:  Adapting geothermal energy to produce ethanol for automotive fuel  P0723 880-4818: Performance monitoring of low energy house, Macciesfield  STEPHENS, D. B. Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  P0670 880-46600	The 20 percent solar energy goal: Is there a plan	
STADBICK, S.  Nickel hydrogen battery advanced development program status report  Nickel hydrogen battery for a spacecraft power subsystem  p0770 A80-48440  STABGE, B. Coal gasification in fluidized bed combustion:  automótive fuel  p0723 A80-4818.  STEPHEN, F. B. Performance monitoring of low energy house, Hacciesfield  p0575 A80-5094  STEPHENS, D. B. Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment p0670 A80-46600		
program status report  p0770 A80-48439  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  p0770 A80-48440  STABGE, B.  Coal gasification in fluidized bed combustion:  STARGE STADBICK S. J.  p0770 A80-48440  STARGE P. B.  Performance monitoring of low energy house,  Hacclesfield  p0575 A80-50944  STAPHERS, D. B.  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  p0670 A80-46600	STADRICK, S.	automotive fuel
p0770 A80-48439  STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  p0770 A80-48440  STARGE, B.  Coal gasification in fluidized bed combustion:  Performance monitoring of low energy house,  Macciesfield  p0575 A80-50940  STEPHESS, D. B.  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  p0670 A80-46600		
STADBICK, S. J.  Nickel hydrogen battery for a spacecraft power subsystem  p0770 A80-48440  STARGE, B.  Coal gasification in fluidized bed combustion:  Hacciesfield  p0575 A80-50946  STEPHENS, D. B.  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  p0670 A80-46606		
subsystem  p0770 A80-48440  STARGE, B.  Coal gasification in fluidized bed combustion:  STRPHERS, D. B.  Highlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  p0670 A80-46600	STADBICK, S. J.	Macclesfield
p0770 A80-48440  STARGE, H.  Coal gasification in fluidized bed combustion:  Bighlights of the LLL Hoe Creek No. 3 underground coal gasification experiment  p0670 A80-4660		
Coal gasification in fluidized bed combustion: p0670 A80-4660	p0770 A80-48440	Highlights of the LLL Hoe Creek No. 3 underground

STEUBERBERG, R. K.	CONUDED D D
Recent progress in lithium/iron sulfide battery	STONEMETS, B. E. Three computer codes to read, plot and tabulate
development	operational test-site recorded solar data
p0762 A80-48188	[NASA-TH-78293] p0644 N80-31879
STEVENS, K.	STORCH, S. H.
Optimized grid patterns for Cu2S-CdS solar cells p0621 A80-49322	Assumptions and ground rules used in nuclear waste projections and source term data
STEWART, J. H.	[ON#I-24] p0585 N80-32203
Emerging materials systems for solar cell	STORTI, 6.
applications: Cu/sub 2-x/Se	Pilot line report: Development of a high
[DOB/RT-23005/T3] p0632 N80-28895 STRWART, R. C.	efficiency thin silicon solar cell [NASA-CR-163522] p0644 N80-31876
Development of molten carbonate fuel cell power	[NASA-CR-163522] p0644 N80-31876 Investigation of the impurity tolerance of
plant technology	semicrystalline silicon solar cells silicon
[DOB/ET-15440/1] p0750 N80-31938	impact program
STRUART, S. D.	[DOB/CH-00178/T2] p0654 N80-32934
Three computer codes to read, plot and tabulate	STOSUB, J. J.
operational test-site recorded solar data [NASA-TH-78293] p0644 N80-31879	Recent activity in U.S. tar sand p0671 A80-48166
STIAGOT, A. S.	STOTTLEMYRE, J. A.
Metallic thermoelectric materials in solar	Temperature-induced permeability alterations in
thermoelectric generators	unconsolidated and consolidated aquifer media
P0610 A80-47152	p0766 A80-48336
STICKLER, D. B. Indirect liquefaction via the Avco coal	STOTTS, B. E. Simulation and a preliminary comparison of passive
gasification system	solar heating systems
p0674 A80-48296	· [ASHE PAPER 80-HT-17] p0611 A80-48008
STIBBER, S. P.	STOY, B.
Experimental investigation of systems for	Solar and wind energy - Its contribution to
diminishing the structural loads of large wind turbines	meeting future power requirements p0623 A80-50816
p0722 A80-47600	STRACK, B. S.
STIGER, B. R.	LLL in situ coal gasification project
Raft Biver 5-MW/e/ geothernal pilot plant	[UCBL-50026-79-4] p0705 N80-31654
p0727 A80-48314	STRASSER, K.
Hydrothermal energy: A source of energy for alcohol production	Development of a 7 kW H2/O2-fuel cell assembly with circulating electrolyte in a compact
[CONF-800526-1] p0698 N80-29869	modular design
STILES, A. B.	p0739 A80-51692
Development of unique catalysts for	STRAUS, J. H.
hydrodenitrogenation of coal-derived liquids	A problem posed by vapour-dominated geothermal
[FE-3297-1] p0690 N80-28482 Development of unique catalysts for	systems p0689 180-54063
hydrodenitrogenation of coal-derived liquids	STERBECY, D. S.
[PB-3297-2] P0690 N80-28545	Solar cells for terrestrial applications
Development of unique catalysts for	p0611 A80-47156
hydrodenitrogenation of coal-derived liquids	Investigation of high-voltage heterophotoconverters
[PE-3297-3] p0690 N80-28546 STILES, B. C.	p0611 A80-47163 STRICKLAND, G.
Refuse/sludge/hazardous waste co-disposal with	Electrolysis-based hydrogen storage technology
energy recovery	[BNL-26923] p0647 N80-31928
p0684 A80-50020	STRINGER, R. P.
STOCKEL, J. P. Status of COMSAT/INTELSAT nickel-hydrogen battery	Research and evaluation of biomass
technology	resources/conversion/utilization systems (market/experimental analysis for development of
p0770 A80-48437	a data base for a fuels from biomass model)
STORSSEL, R.	[DOE/ET-20611/11] p0700 N80-30552
The investment demand of energy economy and its	STROGOBOV, O. V.
financing p0575 A80-50827	Comparative analysis of the basic combustion characteristics of some heavy hydrocarbon fuels
STORWER, E.	in application to aircraft gas turbine engines
European technology applicable to Solar Power	p0721 A80-47424
Satellite Systems (SPS)	STROMBERG, R. P.
[INKA-CONF-79-378-046] p0637 N80-29878	A comparison of the flat plate and concentrating
STOJANOVIC, H. S.  Hybrid system consisting of silicon solar cells	solar collector p0619 A80-48507
with concentrators and heat pump	STOCK, R.
p0608 A80-46792	Improvement of phosphorus diffused silicon solar
STOKES, C. S.	cells by laser treatment
Investigation of fuels containing coal-oil-water emulsions fire tube test apparatus	p0606 A80-46763
[DOE/ET-10634/T1] p0691 N80-28552	Design study of a two-phase turbine bottoming cycle
STOKES, G. N.	[DOE/ET-15350/T1] p0744 N80-30757
Workshop on Satellite Power Systems (SPS) Effects	STURM, J.
on Optical and Radio Astronomy	Potential of diesel engine, emission technology
[CONF-7905143] p0643 N80-31435	[PB80-192685] p0586 N80-32735
STOLTEMAND, D. B.  High-efficiency concentration/multi-solar-cell	SUBRAMANIAN, E.  The power system
system for orbital power generation	p0743 H80-29387
p0614 A80-48207	SUBRAMANIAM, D. V. V.
STONE, A. H.	A horizontal axis sail windmill for use in
Geothermal energy - An overview p0737 A80-50907	irrigation [NAL-TN-54] p0743 N80-29844
STORE, E.	SUCCOP, D. C.
· Characterization of a potential underground coal	Research and development of an advanced process
gasification site in the State of Washington	for conversion of coal to synthetic gasoline and
p0676 A80-48345	other distillate motor fuels [FE-1800-45] p0704 N80-31641

SUCKEVER, S.	•
Experimental evidence of charge-exc	:hange
recombination of highly ionized i	
titanium in Princeton large torus	
CUDIALD I B	p0735 A80-48765
SUBLEIB, L. B. Operational characteristics of a 60	1 10
photovoltaic system integrated wi	
F=====================================	p0609 A80-46797
SUGA, T.	, , , , , , , , , , , , , , , , , , ,
Methanol/ethanol/gasoline blend fue	ls .
demonstration with stratified cha	
vehicles	
[PB80-192123]	P0713 N80-33606
SULLIVAN, J. A.	•
Plash pyrolysis and gasification of	coal through.
laser heating	
	P0672 A80-48244
Plash pyrolysis and gasification of	coal through
laser heating [[LA-UR-80-1094]	p0711 B80~32573
SULLIVAB, L. J.	PO / 11 800~323/3
Development of a 4 kW wind turbine	denerator.
beveropment of a 4 kg sind turbine	p0725 A80~48269
SULLIVAN, P. J.	2
A methodology for the environmental	assessment of
advanced coal extraction systems	•
[NASA-CR-163570]	p0586 N80~32827
SULLIVAN, R. P.	7
Refining and urgrading of synfuels	
oil shales by advanced catalytic	
[FE-2315-40]	p0691 N80-28550
Refining and upgrading of synfuels	
oil shales by advanced catalytic	processes.
Laboratory and pilot plant studie processing of SRC-1	s of the
[PE-2315-45]	p0699 N80-30544
Refining and upgrading of synfuels	
oil shales by advanced catalytic	DIOCESSES
[PE-2315-48]	p07C3 N80-31629
SULLIVAN, S. J.	•
Uranium resources: A review of est	imation
methodologies	
[PB80-193725]	p0714 N80-33920
[PB80-193725] SUMBERS, W. A.	
[PB80-193725] SUMMERS, W. A. Recent progress on the sulfur cycle	
[PB80-193725] SUMBERS, W. A.	hybrid
[PB80-193725] SUMBERS, W. A.  Recent progress on the sulfur cycle hydrogen production process	
[PB80-193725] SUMMBES, W. A. Recent progress on the sulfur cycle hydrogen production process SUMO, W. G.	hybrid p0663 180-48460
[PB80-193725] SUMBERS, W. A. Recent progress on the sulfur cycle hydrogen production process SUMU, W. G. Low maintenance lead-acid batteries	hybrid p0663 180-48460
[PB80-193725] SUMMBES, W. A. Recent progress on the sulfur cycle hydrogen production process SUMO, W. G.	hybrid p0663 A80-48460 for energy
[PB80-193725] SUMMBES, W. A. Recent progress on the sulfur cycle hydrogen production process SUMU, W. G. Low maintenance lead-acid batteries storage	hybrid p0663 180-48460
[PB80-193725] SUMBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMO, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system	hybrid p0663 A80-48460 for energy p0765 A80-48326 research and
[PB80-193725] SUMBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMO, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system	hybrid p0663 A80-48460 for energy p0765 A80-48326 research and
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process SUMU, W. G. Low maintenance lead-acid batteries storage SURBER, P. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary	hybrid p0663 A80-48460 for energy p0765 A80-48326 research and
[PB80-193725]  SUBBERS, W. A.  Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G.  Low maintenance lead-acid batteries storage  SUBBER, F. T.  Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]	hybrid p0663 A80-48460 for energy p0765 A80-48326 research and
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMU, W. G. Low maintenance lead-acid batteries storage  SURBER, F. T. Blectric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SURIABINOVA, T. I.	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272
[PB80-193725]  SUBBERS, W. A.  Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G.  Low maintenance lead-acid batteries storage  SUBBER, F. T.  Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SURBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SURINBINOVA, T. I. Solar cells for terrestrial applica	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMU, W. G. Low maintenance lead-acid batteries storage  SURBBER, F. T. Blectric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-71-VOL-1]  SURIABINOVA, T. I. Solar cells for terrestrial applica	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process SUBU, W. G. Low maintenance lead-acid batteries storage SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-TI-VOL-1] SUBLANIHOVA, T. I. Solar cells for terrestrial applica SUTTEER, E. Study on the utilization of solar e	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SUBLIBINOVA, T. I. Solar cells for terrestrial applica  SUTTEER, K. Study on the utilization of solar e operation of Spacelab material sc	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMU, W. G. Low maintenance lead-acid batteries storage  SUMBBR, F. T. Blectric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SUMINBINOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Siudy on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process SUBU, W. G. Low maintenance lead-acid batteries storage SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-TI-VOL-1] SUBIABINOVA, T. I. Solar cells for terrestrial applica SUTTHER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79] SVIRIDEBEG, B. F.	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBUC, W. G. Low maintenance lead-acid batteries storage  SUBBER, P. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SUBLANIHOVA, T. I. Solar cells for terrestrial applica  SUTTBER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENEO, B. F. Selection of the optimal design par	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process SUBU, W. G. Low maintenance lead-acid batteries storage SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-TI-VOL-1] SUBIABINOVA, T. I. Solar cells for terrestrial applica SUTTHER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79] SVIRIDEBEG, B. F.	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an
[PB80-193725] SUBBES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SUBIANIHOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENGO, E. P. Selection of the optimal design par aircraft flywbeel-type power supp	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391
[PB80-193725] SUBBES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SUBIANIHOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENGO, E. P. Selection of the optimal design par aircraft flywbeel-type power supp	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-TI-VOL-1]  SUBIABINOVA, T. I. Solar cells for terrestrial applica  SUTTHER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENEO, B. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design Study of steel V-Belt CVT fo	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 relectric
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMU, W. G. Low maintenance lead-acid batteries storage  SURBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SURIANIHOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENGO, E. P. Selection of the optimal design par aircraft flywbeel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT for vehicles [NASA-CR-159845]	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMU, W. G. Low maintenance lead-acid batteries storage  SURBER, F. T. Blectric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SURIABINOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENEO, E. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo (vehicles [NASA-CR-159845]  SWAIN, M. R.	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 relectric p0777 N80-32299
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-TI-VOL-1]  SUBTABLHOVA, T. I. Solar cells for terrestrial applica  SUTTHER, K. Study on the utilization of solar e operation of Spacelab material sc [DS-ERT-21-79]  SVIRIDENEO, B. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo vehicles [NASA-CE-159845]  SWAIN, B. R. Hydrogen engine performance analysi	hybrid p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SURBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SURLANIHOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENEO, B. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo vehicles [NASA-CR-159845]  SWAIN, M. R. P. Hydrogen engine performance analysi [SAN-1212-T1]	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 relectric p0777 N80-32299
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMU, W. G. Low maintenance lead-acid batteries storage  SURBBER, F. T. Blectric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SURIABINOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Siudy on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENSO, F. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo vehicles [NASA-CR-159845]  SWAIN, M. R. Hydrogen engine performance analysi [SAB-1212-T1]  SWAININ, D.	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project; p0665 N80-30756
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-TI-VOL-1]  SUBTABHOVA, T. I. Solar cells for terrestrial applica  SUTTHER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENEO, B. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo vehicles [NASA-CR-159845]  SWAIE, M. R. Hydrogen engine performance analysi [SAN-1212-T1]  SWALIOM, D. Results from study of potential ear	hybrid p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project; p0665 N80-30756
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMU, W. G. Low maintenance lead-acid batteries storage  SURBBER, F. T. Blectric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SURIABINOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Siudy on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENSO, F. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo vehicles [NASA-CR-159845]  SWAIN, M. R. Hydrogen engine performance analysi [SAB-1212-T1]  SWAININ, D.	hybrid p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project p0665 N80-30756 ly commercial ETF design work
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMU, W. G. Low maintenance lead-acid batteries storage  SURBBER, F. T. Blectric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SURIABINOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENSO, E. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo ( vehicles [NASA-CR-159845]  SWAIN, M. B. } Hydrogen engine performance analysi [SAB-1212-T1]  SWALLOM, D. Results from study of potential ear HHD power plants and from recent	hybrid p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project; p0665 N80-30756
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-TI-VOL-1]  SUBTABHIOVA, T. I. Solar cells for terrestrial applica  SUTTER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENEO, B. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo vehicles [NASA-CR-159845]  SWAIE, M. R. Hydrogen engine performance analysi [SAN-1212-T1]  SWALLOM, D. Results from study of potential ear NHD power plants and from recent	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project; p0665 N80-30756 ly commercial ETF design work p0717 A80-44107
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMU, W. G. Low maintenance lead-acid batteries storage  SURBBER, F. T. Blectric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SURIABINOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENSO, E. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo ( vehicles [NASA-CR-159845]  SWAIN, M. B. } Hydrogen engine performance analysi [SAB-1212-T1]  SWALLOM, D. Results from study of potential ear HHD power plants and from recent	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project; p0665 N80-30756 ly commercial ETF design work p0717 A80-44107
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-TI-VOL-1]  SUBTABHOVA, T. I. Solar cells for terrestrial applica  SUTTER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENEO, B. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo vehicles [NASA-CR-159845]  SWAIN, B. B. Hydrogen engine performance analysi [SAN-1212-T1]  SWALLOM, D. Results from study of potential ear NHD power plants and from recent  SWARTERGEN, J. C.	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project p0665 N80-30756 ly commercial ETF design work p0717 A80-44107 licon solar cells p0658 N80-33889
[PB80-193725] SUMBRES, W. A. Recent progress on the sulfur cycle hydrogen production process  SUMO, W. G. Low maintenance lead-acid batteries storage  SUMDER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-T1-VOL-1]  SUBIABINOVA, T. I. Solar cells for terrestrial applica  SUTTNER, K. Siudy on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIENDENGO, B. P. Selection of the optimal design par aircraft flywbeel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo vehicles [NASA-CE-159845]  SWAIN, M. B. Hydrogen engine performance analysi [SAN-1212-T1]  SWALLOM, D. Results from study of potential ear BHD power plants and from recent  SWARTZ, C. K. Eadiation damage in high voltage si  SWERNERGEN, J. C. Materials-related design issues in	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project p0665 N80-30756 ly commercial ETF design work p0717 A80-44107 licon solar cells p0658 N80-33889
[PB80-193725] SUBBERS, W. A. Recent progress on the sulfur cycle hydrogen production process  SUBU, W. G. Low maintenance lead-acid batteries storage  SUBBER, F. T. Electric and hybrid vehicle system development project: Hybrid vehi assessment. Volume 1: Summary [CONS-4209-TI-VOL-1]  SUBTABHOVA, T. I. Solar cells for terrestrial applica  SUTTER, K. Study on the utilization of solar e operation of Spacelab material so [DS-ERT-21-79]  SVIRIDENEO, B. F. Selection of the optimal design par aircraft flywheel-type power supp  SWAIN, J. C. Design study of steel V-Belt CVT fo vehicles [NASA-CR-159845]  SWAIN, B. B. Hydrogen engine performance analysi [SAN-1212-T1]  SWALLOM, D. Results from study of potential ear NHD power plants and from recent  SWARTERGEN, J. C.	p0663 A80-48460 for energy p0765 A80-48326 research and cle potential p0583 N80-31272 tions p0611 A80-47156 nergy for the ience furnaces p0640 N80-30349 ameters of an ly system p0761 A80-47391 r electric p0777 N80-32299 s project; p0665 N80-30756 ly commercial ETF design work p0717 A80-44107 licon solar cells p0658 N80-33889

CUTYM D W		
SUIPT, W. M. Methods of improving limestone utilized fluidized bed combustion	ation	in
ST, C. C.	p0672	A80-4817
Calcium/iron disulfide secondary cell		A80-4823
SEE, H. C. Advanced coal liquefaction processes	empha s	ize low
hydrogen consumption	p0676	A80-4838
SEETO, P. U.S. Department of Energy ocean waves currents energy conversion programs		
SZOSTAK, D. J.		180-5367
Amorphous thin films for solar-cell a [DOE/ET-21074/4]		tions #80-3292
Т		: .
TABACK, B. J.	4	
Determination of air pollutant emissi for thermal tertiary oil recovery of California, volume 1	on fac perati	tors ons in
[PB80-187594]		N80-3198
Determination of air pollutant emissi	on fac	cors
for thermal tertiary oil recovery of California. Volume 2: Appendix	PCLUCA	.015 14
[PB80-187602] TABL, R.	p0585	N80-3198
Helium-topping/organic bottoming - Adgressed generation system Exergetic/energet	ic ana	power lysis A80-4824
Theoretical study of absorbed solar e	nergy	in
Theoretical study of absorbed solar e multi-layer absorber coatings for r	eceive	rs of
solar concentrators. II - Heat tran [ASME PAPER 80-HT-105]		nalysis 180-4803
TAKAGI, K.	-	
Performance of the recently developed for the ETS-III batteries		
TAKATSUKI, B.	p0769	A80-4839
The producing mechanism, separative a characteristics of municipal refuse		1
TALANTOV, A. V.		A80-4953
Comparative analysis of the basic com	bustic	ת
characteristics of some heavy hydro in application to aircraft gas turk	oine er	fuels gines 180-4742
TALBERT, S. G.		
Twenty years of experience with well- heat pumps at Battelle's Columbus I	abora t	source ories A80-4848
TALUKDAE, S. N. Application of remote sensing techniq	ues to	,
petroleum exploration in India	n0686	A80-5108
TALWALKAR, A. T.  Heat transfer in slurry preheaters for	_	
liquefaction plants		
TAMORA, K.	-	A80-4843
Improvement in stacking structures of		cells 180-4828
Performance characteristics of noneque generator with fully ionized seed a enlargement of stabilized region	ilibri ad	CEM mp
enial gement of Stabilized Tegion	p0739	A80-5146
TABAKA, T. Investigation of mitrate salts for so	lar la	tent
heat storage		A80-4531
Solar thermal electric power systems	in Jap	
Investigation of nitrate salts for so	lar la	tent
heat storage	p0595	A80-4531
TABBEE, E. G. Tidal energy in the Bay of Fundy	p0688	A80-5368

TRVELDE, J. A.
Autoignition characteristics of aircraft-type fuels
[NASA-CR-159886] p0698 N80-30535

TAQ, W. Energy budget procedures and perform		TRUARI, S. E. A horizontal axis sail windmill for	use in
for energy conserving building is systems	llumination	irrigation [BAL-TH-54]	p0743 180-29844
[PB80-184229] FARR, W. G.	p0583 N80-31673	TRUARY, V. K. Temperature effects in silicon solar	-
New experimental evidence for minor	rity carrier MIS		p0624 A80-51115
diodes	p0600 A80-46695	TRIBE, C.  Early assessment of the photovoltaic	
TABERR, A. R.		potentialities of .RAD polysilicon	
Selectivity improvement in the solution coal process. I - Detailed first-		GHATTON T D	p0600 A80-46701
studies - Coal mineral catalysis		THALLES, L. H. Improvement and scale-up of the HASA	Redox storage
second-stage reaction studies - I coal liquids	Hydrotreating of	system	
coat iiquids	p0679 A80-49630	THAYER, S. B.	p0767 A80-48370
TASCHIBI, A. Integration of photovoltaic general	tion into a	Cost-effective ways to improve the f	
large generating system	TION ANCO G	installation of solar heating and of systems for residences	COOTING
Tier b	P0604 A80-46743	[C00-4520-1]	p0632 N80-28902
TATE, R. E. Parabolic trough solar collector w	ind loading.	THRISEN, R. D. Systems assessment of heavy ion beam	fusion drivers
[SAND-79-2134C]	P0652 N80-32895	[ DOB/DP-40039 ]	p0754 N80-33247
TAUL, J. W., JE.  The economic feasibility of passive	e solar space	THERES, F. Accurate computer analysis of solar	cells
heating systems	-0617 100-51031	including band-gap variation - App.	
TAUSSIG, R. T.	p0627 A80-52832	the Al/x/Ga/1-x/AsGaAs structure	p0607 A80-46782
Photocell heat engine solar power :	p0612 A80-48179	TERVENIE, J.	
Advanced power technology for fusion		Behavior of secondary lithium and al electrodes in propylene carbonate	*
TAYLOR, D.	p0728 A80-48359	THOMAS, G. A.	p0774 180-51690
An algorithm for the preliminary de	esign of	The conversion of refuse into energy	within a
Stirling engine heaters	p0730 A80-48411	regional context	p0680 A80-49938
TAYLOB, B. J.	1 mollo for	THOMAS, H. G.	
Improved alkaline hydrogen/air fue transportation applications	p0726 A80-48282	Catalyst characterization in coal li- [SAND-80-0123] THOMAS, R. B.	p0709 N80-32560
Puel cell applied research: Elect		A high volume process for silicon so	lar cells
materials [BNL-51072]	p0744 N80-29885	using solid diffusion sources	p0601 A80-46707
TAYLOR, L. T.		THOMAS, R. L.	•
Development and application of ana techniques to chemistry of donor		Large wind turbines: A utility opti- generation of electricity	
liquefaction [FE-2696-T4]	p0695 H80-29472	[NASA-TH-81502] THOMAS, E. B. L.	p0752 N80-32858
Development and application of ana	lytical	Sensitivity analysis of the value of	a solar
techniques to chemistry of donor liquefaction	solvent	driven chemical heat pump system	p0616 A80-48287
[DOE/PC-20041/T1]	p0712 N80-33520	THOME-KOZMIENSKY, R. J.	
TAYLOR, P. A. Wake decay and power reduction in	vind farm arrays	Recycling Berlin '79; Proceedings of International Congress, Berlin, Wes	
- An application to the array pro		October 1-3, 1979. Volumes 1 & 2	- 1 The second
Kahuku Hills	p0735 A80-48523	Energy and material recycling	p0680 180-49926
TAYLOR, E. D.	· .		p0680 180-49927
Cost and thermal performance compar systems as applied to passive so		Plue gas recirculation as a means of solid waste incineration process	improving the
TAYLOR, R. W.	p0628 A80-52842	THOMPKINS, B. E.	p0688 A80-53057
Solar retorting of oil shale	•	Amorphous thin films for solar-cell	applications
Solar coal gasification	p0613 A80-48198	[DOB/ET-21074/4] THOMPSON, M. J.	p0653 N80-32921
	p0616 A80-48243	Conduction in sputtered a-Si-H Schot	tky-barrier
Solar gasification of charcoal, wo	p0654 N80-32926	solar cells	p0598 A80-46475
TAYLOR, W. F.:		Contact formation, scaling and optim	isation of
Effect of refining variables on the composition of JF-5	e properties and	large-area R.f. sputtered a-Si Scho solar-cells	ottky parrier
TAZARI, Y.	p0694 N80-29306	THOMPSON, B.	p0602 A80-46721
The fluidized bed gasification of		The effect of demand uncertainty on	
[BLL-RTS-12346] TRMPRST, P.	p0712 N80-33576	economics of electrical generation with differing lead times	technologies
Capital requirements for energy in	the		p0570 A80-46336
industrialised countries	p0572 A80-49393	THOMSON, W. B.  Air/rock storage for solar central re	eceiver power.
TENTSCHER, EH. Advanced thin silicon solar cell w	ith controlled	stations	p0613 180-48196
optical absorptance		THOR, S. B.	· .
TERHORST, W.	p0601 A80-46710	Safety of wind energy conversion systems of study	cems (W1CS):
Energy models as a tool for planning		[PFA-HU-2126]	p0742 N80-28933
TRVELDE, J. A.	p0577 A80-54035	THORNALL, J. W. Coplanar back contacts for thin silic	
Autoignition characteristics of air	craft-type fuels p0698 N80-30535	[NASA-CR-159811]	p0630 N80-28860

· · · · · · · · · · · · · · · · · · ·	•
THORETON, J. Investigation of learning and experience curves [SERI/TR-353-459] p0646 E80-31911	TRELA, B. Status of the Pord program to evaluate ceramics for stator applications in automotive gas
THORNTON, R. H. Automotive fuels from cellulose materials	turbine engines p0720 180-45375
[NZERDC-49] p0710 N80-32571 THORSES, R. S.	TRELLA, T. Potential of diesel engine, 1979 summary source
Department of Housing and Orban Development solar hot water initiative: Centralized coordination	document [PB80-193659] p0585 880-32734
of technical tasks and system evaluation [PB80-189244] p0656 B80-32961	Potential of diesel engine, emission technology [PB80-192685] p0586 B80-32735
THORSHESS, C. B.	TRENKÀ, A. R.
Highlights of the LLL Hoe Creek Ho. 3 underground coal gasification experiment	Interim status report on DOE prototype development SWECS
p0670 A80-46606 Results from the Hoe Creek Ho. 3 underground coal	p0726 A80-48270 TRBEKLER, H. An attempt at balancing the environmental effects
gasification experiment p0675 A80-48340 TIELEHAN, H. W.	of electric power generation with the framework of the country's economic system
An investigation of wind loads on solar collectors	p0575 A80-50820
[PB80-158744] p0633 #80-28936 An investigation of wind loads on solar collectors. Appendix 1: Data listing for top and bottom of collector	TRESTER, B. W.  High-temperature thermochemical water splitting  cycle fusion reactor design considerations  p0663 A80-48449
[PB80-158751] p0633 N80-28937	Hydrogen production by the GA sulfur-iodine process [GA-A-15777-REV] p0666 N80-31651
Establishment of parameters for production of long life nickel oxide electrodes for nickel-hydrogen	TRIBOULET, R. CdTe homo junctions solar cells
cells . p0771 A80-48445	p0603 A80-46731 TRIBUTSCH <sub>e'</sub> H <sub>e</sub>
TISON, N. E. Solar/hydrogen systems assessment. Volume 1:	Photo-intercalation - Possible application in solar energy devices
Solar/hydrogen systems for the 1985 - 2000 time	P0620 A80-48548
frame [NASA-CE-163392] p0665 N80-28865	TRIMBLE, L. C. Review of mini-OTRC performance
TITILE, E.  The combined firing of coal and waste derived fuel	p0727 A80-48347 TRIBDADE, S. C.
in steam raising plant p0681 180-49956	Permentation ethanol as a petroleum substitute p0675 A80-48324
TODD, A. H. H. The Spheromak fusion reactor p0733 180-48495	TROMSON-CARLI, A.  Alsh as a candidate material for photovoltaic solar energy conversion
TODD, T. W.	p0608 A80-46787
Particle confinement scaling experiments in the Culham Levitron p0719 A80-44657	TRUEK, T. J. Sulfate in diesel exhaust p0575 A80-50528
TOPIGHI, A.	TRUES, D. T.
Note on the condensation of the vapor phase above a melt of iron oxide in a solar parabolic concentrator	The operating region of MHD generators p0739 180-51721 TRUSCELLO, V. C.
p0611 A80-47664 TORACIRLO, R.	The JPL parabolic dish project p0618 A80-48417
n-CdS/p-Si heterojunction solar cells p0626 A80-52498	TREASECHA, W. P. Near term commercialization of MHD power
TOHCRUE, 2.  Evaluation of high temperature Likl/TiS2 cells	generation using coal/oil fuel p0724 180-48225
P0773 A80-50508	TSAI, MJ. Oxide/semiconductor photovoltaic heterojunctions
Co-combustion trials of pretreated solid urban refuse, on a brown coal-fired boiler	based on CdTe or InP p0603 A80-46732
p0681 A80-49957	TSANG, C. P. Experimental and theoretical studies of thermal
The combined firing of coal and waste derived fuel in steam raising plant	energy storage in aquifers
p0681 A80-49956	TSINRING, SH. B.
TOWLE, S. User evaluation study of passive solar residences [SERI/TF-63-350] p0638 M80-29882	Some perspectives on the use of powerful gyrotrons for the electron-cyclotron plasma heating in large tokamaks
TOWESEND, W. G. Degradation effects in silicon Schottky barrier	p0738 A80-51038 TSUDA, S.
solar cells p0601 180-46709	Botating strength of laminated composite discs p0762 A80-47454
TRACESEL, C. A.  Energy conversion considerations of the STARFIRE	TSVETKOV, A. L. Estimating capacity of solar thermoelectric
connercial fusion power plant p0733 A80-48490	generator /STEG/ panels p0610 180-47155
TRANSMEIR, G. D. A review of the methods for passive solar systems	TULLER, H. L.  Models for the photoelectrolytic decomposition of
analysis [AD-A087509] p0645 M80-31895	water at semiconducting oxide anodes p0664 A80-50512
TREADWRLL, G. W. Analysis of the influence of geography and weather	TULLI, 6. F. Design of a photovoltaic system for a southwest
on parabolic trough solar collector design [SAND-79-2032] p0631 880-28876	all-electric residence [SAND-79-7056] p0637 #80-29876
TREFFEY, J.  Thermoelectric properties of bismuth-antimony thin	TULLY, B.  The use of solar energy for cooking
films	p0659 n80-33953

p0729 A80-48391.

	••
TUOMI, D. Thermoelectricity - Phase diagrams and	. <b>v</b>
imperfection structures. II p0731 A80-48434	VACATELLO, H.
TUPIRL, I.  Life cycle cost analysis in residential buildings	The layer perovskites as thermal energy storage systems
and consumer appliances p0572 A80-48515	P0761 A80-45315
TORNBULL, P. G.  Regenerative flywheel energy storage system [UCRL-13982-REV-1] p0775 #80-28884	Large wind turbine generator performance assessment [EPRI-AP-1317] p0751 M80-31960 VAIDYAWATMAN, T. S.
TURKER, C. B.	Photocell heat engine solar power systems
Bydration of 'spent' limestone and dolomite to enhance sulfation in fluidized-bed combustion pd672 A80-48172	p0612 A80-48179 Advanced power technology for fusion reactors p0728 A80-48359
TURNER, G. W. High-efficiency InP homojunction solar cells p0598 180-46496	VAISUIS, A.  A study of a space communication system for the control and monitoring of the electric
TORBER, J. A. Photoelectrochemistry with p-Si electrodes -	distribution system. Volume 1: Summary [NASA-CR-163477] p0760 N80-31268
Bffects of inversion p0737 A80-50760	VALGORA, M. E. Power management for multi-100 KWe space systems
TORNER, R. H. High temperature thermal energy storage in steel	p0758 A80-48357
and sand	Influence of meteorological conditions on the
[NASA-CR-159708] p0776 N80-29860 TUTER, L. D.	design of solar energy dc-ac inverters p0609 A80-46795
Thermal stress in a composite cylinder by finite difference technique	VAN MEERBERGEN, J. Experimental optimization of the efficiency of
[ASHE PAPER 80-HT-107] p0612 A80-48036	n/+/-p-p/+/ and p/+/-n-n/+/ silicon solar cells p0601 A80-46706
UELAND, M.	VAM GRIRBARGER, R. L. On the influence of an interfacial oxide layer on Au/n-GaAs Schottky barrier solar cells
Solar atrium: A hybrid solar heating and cooling	P0608 A80-46784
[DOE/CS-34135/6] p0633 M80-28928 Solar atrium: A hybrid solar heating and cooling	Boonomic and technical evaluation of the Ames, lowa solid waste recovery system
system [ALO-4135-T2] p0639 N80-29899	p0683 A80-50005
OBBISHI, K. New method to determine the independent shear	Nickel-hydrogen batteries for INTELSAT V p0770 A80-48438
moduli of transversely isotropic materials [CONF-800575-1] p0712 880-32796 UMENO, M.	VAN OVERSTRAETEN, R. Photovoltaic Solar Energy Conference, 2nd, Berlin, West Germany, April 23-26, 1979, Proceedings
Theoretical analysis of new wavelength-division solar cells p0622 180-50745	p0600 A80-46694  Experimental optimization of the efficiency of n/+/-p-p/+/ and p/+/-n-n/+/ silicon solar cells
UHGER, H. Advanced coal liquefaction processes emphasize low	p0601 180-46706 Incluence of the double exponential on the
hydrogen consumption p0676 A80-48380 LC-Fining of solvent refined coal - SEC-I and	efficiency and the yield of screen printed solar cells
short contact time coal extracts	P0606 A80-46764
p0678 A80-48431 Simulation of the energy-industry-environment	The MARK-13 process for hydrogen production p0662 A80-48412
system for limited economic regions, using the example of Baden-Wuerttemberg. Part 1: Data, model development adaptation	VANCE, J. S.  Research and development for inertial energy storage based on a flexible flywheel
[IKE-K-54-20-PT-1] p0589 N80-32974	[SAND-79-7097] p0778 N80-32898
URABE, S. The producing mechanism, separative and fuel	VANDER PLAS, H. A. Operation of multi-bandgap concentrator cells with
characteristics of municipal refuse p0679 A80-49539	a spectrum splitting filter p0604 A80-46740
URBBB, A. I.  Plue gas recirculation as a means of improving the solid waste incineration process	High-efficiency AlGals/Gals concentrator solar cells by organometallic vapor phase epitary p0610 A80-46952
P0688 A80-53057	TANDERELST, E. J. The aerodynamics of contra-rotating axial flow
Thermodynamic and economic analysis of heat pumps for energy recovery in industrial processes	wind power turbines
[ASHE PAPER 78-WA/HT-64] P0686 A80-52049	VANDERGERST, P.
URTING, P. A.  Vapor cloud explosion studies in the United States p0590 M80-33595	A theoretical study of the modelling and control of a solar water electrolysis plant p0621 A80-48919
USBER, J. L. Blanket options for high-efficiency fusion power	VANDERWALL, E. S. Study of gelled LNG
p0729 A80-48360 USOV, V. G. Some perspectives on the use of powerful gyrotrons	[DOZ/EV-02057/12] p0695 N80-29506  VANDEVENDER, J. P.  Pulsed power accelerators for particle beam fusion
for the electron-cyclotron plasma heating in large tokamaks	[SAND-80-0550C] p0715 N80-34239 VANGOOL, H.
p0738 A80-51038	Assessment of industrial energy conservation by unit processes
· · · · · · · · · · · · · · · · · · ·	[OBAU/IEA-80-4(M)] p0584 M80-31939 VANHOUTTE, G.
	Survey of semiconductor combinations for optimum heterojunction thin film solar cells
	p0605 A80-46753

p0605 A80-46753

	•		
VAROLI, K.		Applications of free-piston Stirlin	ng engines
Solar energy utilization in a colle		• •	. p0732 A80-4845
The Pribourg Solar House in Brisg	p0620 A80-48795	An advanced 15 kW solar powered fre Stirling engine	ee-piston
VARDON, J. H.			p0619 A80-4846
Solar powered absorption air condit	ioning p0629 180-53475	VISKABTA, B. A two-dimensional analysis of flat	nlato
VAS. I. B.	poc29 200-33473	air-heating solar collectors	prace .
Review of the current status of the	vind energy	[ASME PAPER 80-HT-117]	p0612 A80-4803
innovative systems projects [SEBI/TP-635-469]	p0694 880-28892	VISSERS, Di B. Evaluation of high temperature LiAl	l/Tis2 colls
VASAUTH, R. L.	P4034 B00-20032	Everacion of migh compensate him	p0773 A80-5050
An accelerated test design for use	with	VITRO, J.	-111
synchronous orbit	p0770 A80-48401	Properties of a solar alumina-boros	silicate steet
VEDAH, K.		[SERI/TP-334-565]	p0641 N80-3053
Controlled cadmium telluride thin i		VIVIRITO, J. R. AC/DC power converter for batteries	. and fual calls
<ul> <li>cell applications (emerging mater for solar cell applications)</li> </ul>	idis systems	[EPRI-EM-1286]	p0750 N80-3193
* [DOE/RT-23023/T3]	p0642 N80-30921	VLADIMIROV, V. V.	•
VERNEUIZEN, S. D. Vind resource assessment in the upp	er Skagit River	Magnetoplasma compressor with an ex magnetic power generator	throsiou-grisen
Valley of Washington	· ·		p0717 A80-4418
VERBEIANI, P.	p0675 A80-48319	Transient response of a latent heat	· storego nnit -
Remote sensing applied to the prosp	ecting of	An analytical and experimental in	
geothermal anomaly in Caldas Nova	s County, State	[ASME PAPER 79-HT-36]	p0761 A80-4572
of Goias,:Brazil [IBFE-1792-BPB/164]	p0712 N80-32837	Monitoring of the performance of a and cooled apartment building	solar heated
verkatarahahah, s. t.		[DSE-5235-T1]	p0653 N80-3291
The power system	p0743 H80-29387	Indirect liquefaction via the Avco	coal
VERTO, G.		gasification system	
High efficiency silicon solar cell	for	TOR CURTORD B	p0674 A80-4829
concentrator systems	p0606 A80-46767	The combustion engineering approach	to municipal
ARHWHOG T. B.		solid waste energy recovery	_
Sandia battery program for energy s photovoltaic systems	storage in	VORA, B. K.	p0681 A80-4995
•	p0767 A80-48368	Historical development of the U-GAS	process at the
VERIE, C. Alsh as a candidate material for ph	otovoltaic	IGT pilot plant	p0673 A80-4824
	.00.010410	VORHOLE, F.	P0073 200 4024
solar energy conversion			
,	p0608 A80-46787	The significance of the gas economy	
VERHA, A.	_	The significance of the gas economy viewpoint of environmental protections	
VERHA, A. Off-peak power for hydrogen product	_	<pre>vieupoint of environmental protec</pre>	p0575 A80-5082
VERNA, A. Off-peak power for hydrogen product VERNEULES, T.	ion p0663 A80-48461	Viewpoint of environmental protect VORIS, B. Energy/Environment 4: Proceedings	tion p0575 A80-5082 of the National
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions	tion p0663 A80-48461 sts and reaction	Vieupoint of environmental protect  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene B and D Program	tion p0575 A80-5082 of the Mational ergy/Environment
VERHA, A. Off-peak power for hydrogen product VERHEULES, T. Liquid fuels from biomass: Catalys conditions [LBI-9789]	ion p0663 A80-48461	Viewpoint of environmental protect VORIS, B. Energy/Environment 4: Proceedings Conference on the Interagency Ene B and D Program [PB80-177942]	tion p0575 A80-5082 of the National
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, E. F. Study of methane fuel for subsonic	p0663 A80-48461 sts and reaction p0705 H80-31646	Viewpoint of environmental protect VORIS, B. Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942] VOSBURGH, P. H. Vind commercialization and Alcoa Ve	tion p0575 A80-5082 of the Mational ergy/Environment p0581 M80-2992
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, E. P. Study of methane fuel for subsonic aircraft	p0663 A80-48461 sts and reaction p0705 H80-31646 transport	Viewpoint of environmental protect VORIS, B. Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80~177942] VOSBURGH, P. B.	etion p0575 A80-5082 of the National ergy/Environment p0581 N80-2992 ertical Axis
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, E. F. Study of methane fuel for subsonic aircraft [HASA-CE-159320] VERSPURTER, E. S.	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533	Viewpoint of environmental protect  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene is and D Program [PB80-177942]  VOSBURGH, P. B.  Vind commercialization and Alcoa Vereind Turbines  VOZOFF, K.	of the National of the National orgy/Environment p0581 N80-2992 ortical Axis
VERHA, A. Off-peak power for hydrogen product VERHEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, E. F. Study of methane fuel for subsonic aircraft [MASA-CE-159320] VERSPURTEN, E. S. On the influence of an interfacial	p0663 A80-48461 sts and reaction p0705 W80-31646 transport p0708 W80-32533 oxide layer on	Viewpoint of environmental protect VORIS, B. Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB60-177942] VOSBURGH, P. B. Vind commercialization and Alcoa Ve- Hind Turbines	of the Mational ergy/Environment p0581 M80-2992 ertical Axis p0687 A80-5286 geophysics
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, E. F. Study of methane fuel for subsonic aircraft [HASA-CE-159320] VERSPURTER, E. S.	p0663 A80-48461 sts and reaction p0705 W80-31646 transport p0708 W80-32533 oxide layer on	Viewpoint of environmental protect  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene is and D Program [PB80-177942]  VOSDURGH, P. B.  Wind commercialization and Alcoa Vereind Turbines  VOXOFF, E. Electromagnetic methods in applied  VRABLE, D. L.	of the National argy/Environment p0581 N80-2992 artical Axis p0687 A80-5286 geophysics p0669 A80-4617
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, E. F. Study of methane fuel for subsonic aircraft [WASA-CE-159320] VERSEURTEN, E. S. On the influence of an interfacial Au/n-Gaas Schottky barrier solar VERSEER, J. L.	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784	VORIS, B. Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942] VOSBURGH, P. N. Vind commercialization and Alcoa Versiand Turbines  VOROFF, K. Electromagnetic methods in applied	of the Mational po575 A80-5082  of the Mational prgy/Environment p0581 M80-2992  ertical Axis p0687 A80-5286  geophysics p0669 A80-4617
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, E. F. Study of methane fuel for subsonic aircraft [HASA-CE-159320] VERSPURTEN, E. S. On the influence of an interfacial Au/n-Gals Schottky barrier solar	p0663 A80-48461 sts and reaction p0705 R80-31646 transport p0708 R80-32533 oxide layer on cells p0608 A80-46784	VORIS, B. Energy/Environment 4: Proceedings Conference on the Interagency Ene is and D Program [PB80-177942] VOSBURGH, P. M. Find commercialization and Alcoa Verind Turbines  VOZOFF, K. Electromagnetic methods in applied  WRABLE, D. L. Design of the HTGR for process heat	of the National of the National orgy/Environment p0581 N80-2992 ortical Axis p0687 A80-5286 geophysics p0669 A80-4617
VERNA, A. Off-peak power for hydrogen product VERNBULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, R. F. Study of methane fuel for subsonic aircraft [NASA-CR-159320] VERSPURTEN, E. S. On the influence of an interfacial Au/n-Galas Schottky barrier solar VERSTER, J. L. An emissometer with high accuracy for	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 cor	Viewpoint of environmental protect  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene is and D Program [PB80-177942]  VOSDURGH, P. B.  Wind commercialization and Alcoa Vereind Turbines  VOXOFF, E. Electromagnetic methods in applied  VRABLE, D. L.	of the Mational po575 A80-5082  of the Mational prgy/Environment p0581 M80-2992  ertical Axis p0687 A80-5286  geophysics p0669 A80-4617
VERHA, A. Off-peak power for hydrogen product VERHEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, R. F. Study of methane fuel for subsonic aircraft [NASA-CR-159320] VERSPURTEN, E. S. On the influence of an interfacial Au/n-Galas Schottky barrier solar VERSTER, J. L. An emissometer with high accuracy f determination of the total hemisp emittance of surfaces	p0663 A80-48461 sts and reaction p0705 R80-31646 transport p0708 R80-32533 oxide layer on cells p0608 A80-46784	VORIS, B. Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942] VOSBURGH, P. B. Vind commercialization and Alcoa Vereind Turbines  VOROFF, E. Electromagnetic methods in applied  VRABLE, D. L. Design of the HTCR for process heat	of the Mational po575 A80-5082  of the Mational prgy/Environment p0581 M80-2992  ertical Axis p0687 A80-5286  geophysics p0669 A80-4617
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, E. F. Study of methane fuel for subsonic aircraft [HASA-CE-159320] VERSPURTEN, E. S. On the influence of an interfacial Au/n-Gals Schottky barrier solar VERSTER, J. L. An emissometer with high accuracy f determination of the total hemisp emittance of surfaces VEZIROGLU, T. L. Assessment of hydrogen compressor te	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 cor cherical p0621 A80-48947	VORIS, B. Energy/Environment 4: Proceedings Conference on the Interagency Ene is and D Program [PB80-177942] VOSBURGH, P. M. Find commercialization and Alcoa Verind Turbines  VOZOFF, K. Electromagnetic methods in applied  WRABLE, D. L. Design of the HTGR for process heat	of the Mational properties and
VERNA, A. Off-peak power for hydrogen product VERNBULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, R. F. Study of methane fuel for subsonic aircraft [NASA-CR-159320] VERSPURTEN, E. S. On the influence of an interfacial Au/n-Galas Schottky barrier solar VERSTER, J. L. An emissometer with high accuracy f determination of the total hemisp emittance of surfaces VEZIROGLU, T. L. Assessment of hydrogen compressor t energy storage and transmission s	p0663 A80-48461 sts and reaction p0705 W80-31646 transport p0708 W80-32533 oxide layer on cells p0608 A80-46784 for cherical p0621 A80-48947	VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942]  VOSBURGH, P. B. Vind commercialization and Alcoa Vereind Turbines  VOROFF, K. Electromagnetic methods in applied  VRABLE, D. L. Design of the HTCR for process heat  WABREK, R. H. Cassegrain solar concentrators for	of the National rgy/Environment p0581 N80-2992 ertical Axis p0687 A80-5286 geophysics p0669 A80-4617 applications p0758 A80-4831
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, E. F. Study of methane fuel for subsonic aircraft [MASA-CE-159320] VERSPURTEN, E. S. On the influence of an interfacial Au/n-Gals Schottky barrier solar VERSTER, J. L. An emissometer with high accuracy f determination of the total hemist emittance of surfaces  VEZIROGLU, T. L. Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-71] VIEUI-ROCHAZ, L.	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 cor cherical p0621 A80-48947 sechnology for systems p0667 H80-32922	VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene is and D Program [PB80-177942]  VOSBURGH, P. B. Wind commercialization and Alcoa Vereind Turbines  VOROFF, E. Electromagnetic methods in applied  VRABLE, D. L. Design of the HTCR for process heat  WABREE, R. B.	of the Mational rgy/Environment p0581 M80-2992 ertical Axis p0687 A80-5286 geophysics p0669 A80-4617 applications p0758 A80-4831
VERNA, A. Off-peak power for hydrogen product VERNBULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERSAW, R. F. Study of methane fuel for subsonic aircraft [NASA-CR-159320] VERSPURTEN, E. S. On the influence of an interfacial Au/n-Galas Schottky barrier solar  VERSTER, J. L. An emissometer with high accuracy f determination of the total hemisp emittance of surfaces  VEZIROGLU, T. B. Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1]  VIEUL-ROCCHAZ, L. Schottky barriers on sputtered hydrogen	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 or cherical p0621 A80-48947 echnology for systems p0667 H80-32922	VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942]  VOSBURGH, P. B. Vind commercialization and Alcoa Vereind Turbines  VOROFF, K. Electromagnetic methods in applied  VRABLE, D. L. Design of the HTGR for process heat  W  WABREK, R. B. Cassegrain solar concentrators for  VACHTELL, G. P. Self controlling, self pumping heat system study	of the National argy/Environment p0581 N80-2992 artical Axis p0687 A80-5286 geophysics p0669 A80-4617 applications p0758 A80-4831 photovoltaics p0608 A80-4679 circulation
VERNA, A.  Off-peak power for hydrogen product  VERNEULES, T.  Liquid fuels from biomass: Catalys conditions [LBL-9789]  VERSAW, E. F.  Study of methane fuel for subsonic aircraft [MASA-CE-159320]  VERSPURTEN, E. S.  On the influence of an interfacial Au/n-Gals Schottky barrier solar  VERSTER, J. L.  An emissometer with high accuracy f determination of the total hemist emittance of surfaces  VEZIROGLU, T. L.  Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-71]  VIEUI-ROCHAZ, L.	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 sor cherical p0621 A80-48947 echnology for systems p0667 N80-32922 cogenated properties and	VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene is and D Program [PB80-177942]  VOSDURGH, P. B. Vind commercialization and Alcoa Verind Turbines  VOZOFF, E. Electromagnetic methods in applied  WRABLE, D. L. Design of the HTGR for process heat  W  WABREK, R. H. Cassegrain solar concentrators for  WACHTELL, G. P. Self controlling, self pumping heat system study [COO-4484-07]	of the Mational rgy/Environment p0581 M80-2992 ertical Axis p0687 A80-5286 geophysics p0669 A80-4617 applications p0758 A80-4831
VERNA, A.  Off-peak power for hydrogen product  VERNBULES, T.  Liquid fuels from biomass: Catalys conditions [LBL-9789]  VERSAW, R. F.  Study of methane fuel for subsonic aircraft [NASA-CR-159320]  VERSPURTEN, E. S. On the influence of an interfacial Au/n-Galas Schottky barrier solar  VERSTER, J. L.  An emissometer with high accuracy f determination of the total hemisp emittance of surfaces  VEZIROGLU, T. L. Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1]  VIEUI-ROCHAZ, L. Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 sor cherical p0621 A80-48947 echnology for systems p0667 N80-32922 cogenated properties and	VIEWPOINT OF ENVIRONMENTAL PROTECTION  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942]  VOSBURGH, P. B.  Vind commercialization and Alcoa Vereind Turbines  VOXOPP, K.  Electromagnetic methods in applied  VRABLE, D. L.  Design of the HTGR for process heat  W  WABREK, R. B.  Cassegrain solar concentrators for  WACHTELL, G. P.  Self controlling, self pumping heat system study [COC-4484-07]  WADE, D. T.  Exton Donor Solvent Coal Liquefaction	of the Mational rgy/Environment p0581 M80-2992 ertical Axis p0687 A80-5286 geophysics p0669 A80-4617 applications p0758 A80-4831 photovoltaics p0608 A80-4679 circulation p0656 M80-3295
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERNAU, R. F. Study of methane fuel for subsonic aircraft [MASA-CE-159320] VERSPUETEN, E. S. On the influence of an interfacial Au/n-Galas Schottky barrier solar  VERSTER, J. L. An emissometer with high accuracy f determination of the total hemisp emittance of surfaces  VEZIROGLU, T. L. Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1] VIRUI-ROCHAZ, L. Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 sor cherical p0621 A80-48947 echnology for systems p0667 H80-32922 cogenated properties and cs p0602 A80-46720	VORIS, B. Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942] VOSBURGH, P. N. Wind commercialization and Alcoa Vereind Turbines  VOXOFF, K. Electromagnetic methods in applied  VRABLE, D. L. Design of the HTGR for process heat  WABREK, R. N. Cassegrain solar concentrators for  EACHTELL, G. P. Self controlling, self pumping heat system study [C00-4484-07] WADE, D. T.	post on post of the National orgy/Environment post National post National post National argy/Environment post National Axis post National Axis post National Axis post National National Post National Post National National Post National N
VERNA, A.  Off-peak power for hydrogen product  VERNBULES, T.  Liquid fuels from biomass: Catalys conditions [LBL-9789]  VERSAW, R. F.  Study of methane fuel for subsonic aircraft [NASA-CR-159320]  VERSPURTEN, E. S. On the influence of an interfacial Au/n-Galas Schottky barrier solar  VERSTER, J. L.  An emissometer with high accuracy f determination of the total hemiss emittance of surfaces  VEZIROGLU, T. B. Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1]  VIEUI-ROCHAZ, L. Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VIEUEBOLE, B. Bydrogen storage in magnesium powde	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 sor cherical p0621 A80-48947 echnology for systems p0667 H80-32922 cogenated properties and cs p0602 A80-46720	VIEWPOINT OF ENVIRONMENTAL PROTECTION  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942]  VOSBURGH, P. B.  Vind commercialization and Alcoa Ve Wind commercialization and Alcoa Ve Wind Turbines  VOXOPP, K.  Electromagnetic methods in applied  VRABLE, D. L.  Design of the HTGR for process heat  W  WABREK, R. B.  Cassegrain solar concentrators for  WACHTELL, G. P.  Self controlling, self pumping heat system study [COC-4484-07]  WADE, D. T.  Exton Donor Solvent Coal Liquefacti Development Program Status  WADE, J. E.	post and pos
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERNAU, R. F. Study of methane fuel for subsonic aircraft [MASA-CE-159320] VERSPUETEN, E. S. On the influence of an interfacial Au/n-Gals Schottky barrier solar  VERSTER, J. L. An emissometer with high accuracy f determination of the total hemisp emittance of surfaces  VEZIROGLU, T. B. Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1] VIEUI-ROCHAZ, L. Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VIGEBOLE, B. Eydrogen storage in magnesium powder  VIKTOROVITCE, P.	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 sor cherical p0621 A80-48947 echnology for systems p0667 N80-32922 cogenated properties and cs p0602 A80-46720 er p0664 A80-50623	VIEWPOINT OF ENVIRONMENTAL PROCEEDINGS  FINE TYPE TO THE PROCEEDINGS  CONFERENCE ON THE INTERAGENCY ENGINE RAND D PROGRAM  [PB80-177942]  VOSDUBGH, P. B.  VIND COMMERCIALIZATION AND ALCOA VERIND TURBINGS  VOXOFF, R.  Electromagnetic methods in applied  VRABLE, D. L.  Design of the HTGR for process heat  W  WABREK, R. B.  Cassegrain solar concentrators for  WACHTELL, G. P.  Self controlling, self pumping heat system study  [COU-4484-07]  WADE, D. T.  Exton Donor Solvent Coal Liquefactic Development Program Status  WADE, J. E.  Vegetation as an indicator of high	of the National orgy/Environment p0581 N80-2992 ortical Axis p0687 A80-5286 geophysics p0669 A80-4617 applications p0758 A80-4831  Photovoltaics p0608 A80-4679 circulation p0656 N80-3295 on Process - p0677 A80-4843 wind velocity
VERNA, A.  Off-peak power for hydrogen product  VERNBULES, T.  Liquid fuels from biomass: Catalys  conditions [LBL-9789]  VERSAW, R. F.  Study of methane fuel for subsonic aircraft [NASA-CR-159320]  VERSPURTEN, E. S.  On the influence of an interfacial Au/n-Galas Schottky barrier solar  VERSTER, J. L.  An emissometer with high accuracy f determination of the total hemisp emittance of surfaces  VEZIROGLU, T. L.  Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1]  VIEUI-ROCHAZ, L.  Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VIGEBOLE, B.  Hydrogen storage in magnesium powder  VIKTOROVITCH, P.  Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic	p0663 A80-48461 sts and reaction p0705 R80-31646 transport p0708 R80-32533 oride layer on cells p0608 A80-46784 sor cherical p0621 A80-48947 sechnology for systems p0667 R80-32922 cogenated properties and cs p0602 A80-46720 sr p0664 A80-50623 cogenated properties and	VIEWPOINT OF ENVIRONMENTAL PROTECTION  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942]  VOSBURGH, P. B.  Vind commercialization and Alcoa Ve Wind commercialization and Alcoa Ve Wind Turbines  VOXOPP, K.  Electromagnetic methods in applied  VRABLE, D. L.  Design of the HTGR for process heat  W  WABREK, R. B.  Cassegrain solar concentrators for  WACHTELL, G. P.  Self controlling, self pumping heat system study [COC-4484-07]  WADE, D. T.  Exton Donor Solvent Coal Liquefacti Development Program Status  WADE, J. E.	post and pos
VERNA, A. Off-peak power for hydrogen product  VERNBULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789]  VERNAW, R. F. Study of methane fuel for subsonic aircraft [WASA-CE-159320]  VERSPURTEN, R. S. On the influence of an interfacial Au/n-Gals Schottky barrier solar  VERSTER, J. L. An emissometer with high accuracy f determination of the total hemiss emittance of surfaces  VEZIROGLU, T. B. Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1]  VIRUI-ROCHAZ, L. Schottky barriers on sputtered hydrogenical capacitance-voltage characteristic  VIGEBOLE, B. Bydrogen storage in magnesium powder  VIKTOROVITCH, P. Schottky barriers on sputtered hydrogenical surfaces	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 sor sherical p0621 A80-48947 sechnology for systems p0667 H80-32922 cogenated properties and cs p0664 A80-50623 cogenated properties and cs	VIEWPOINT OF ENVIRONMENTAL PROCEEDINGS  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene is and D Program [PB80-177942]  VOSDURGH, P. B.  Vind commercialization and Alcoa Vereind Turbines  VOZOFF, E.  Electromagnetic methods in applied  VRABLE, D. L.  Design of the HTGR for process heat  W  WABREK, R. H.  Cassegrain solar concentrators for  WACHTELL, G. R.  Self controlling, self pumping heat system study [COO-4484-07]  WADE, D. T.  Exton Donor Solvent Coal Liquefacti Development Program Status  WADE, J. E.  Vegetation as an indicator of high [ELO-2227-TZ4-79/1]  WAGER, C. E.  Upgraded automotive gas turbine eng	post section post
VERNA, A.  Off-peak power for hydrogen product  VERNBULES, T.  Liquid fuels from biomass: Catalys  conditions [LBL-9789]  VERSAW, R. F.  Study of methane fuel for subsonic aircraft [NASA-CR-159320]  VERSPURTEN, E. S.  On the influence of an interfacial Au/n-Galas Schottky barrier solar  VERSTER, J. L.  An emissometer with high accuracy f determination of the total hemisp emittance of surfaces  VEZIROGLU, T. L.  Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1]  VIEUI-ROCHAZ, L.  Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VIGEBOLE, B.  Hydrogen storage in magnesium powder  VIKTOROVITCH, P.  Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic	p0663 A80-48461 sts and reaction p0705 R80-31646 transport p0708 R80-32533 oride layer on cells p0608 A80-46784 sor cherical p0621 A80-48947 sechnology for systems p0667 R80-32922 cogenated properties and cs p0602 A80-46720 sr p0664 A80-50623 cogenated properties and	VIEWPOINT OF ENVIRONMENTAL PROCEEDINGS  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB60-177942]  VOSBURGH, P. B.  Vind commercialization and Alcoa Vereind Turbines  VOZOPP, K.  Electromagnetic methods in applied  VRABLE, D. L.  Design of the HTGR for process heat  W  WABREK, R. B.  Cassegrain solar concentrators for  WACHTELL, G. P.  Self controlling, self pumping heat system study [COC-4484-07]  WADE, D. T.  Exxon Donor Solvent Coal Liquefactic Development Program Status  WADE, J. E.  Vegetation as an indicator of high [RLO-2227-T24-79/1]  WAGEER, C. B.	post section posts and section posts and section posts are posts posts posts posts are posts and section posts are p
VERNA, A. Off-peak power for hydrogen product VERNEULES, T. Liquid fuels from biomass: Catalys conditions [LBL-9789] VERNAU, R. F. Study of methane fuel for subsonic aircraft [MASA-CE-159320] VERSPUETEN, E. S. On the influence of an interfacial Au/n-Gals Schottky barrier solar  VERSTER, J. L. An emissometer with high accuracy f determination of the total hemisp emittance of surfaces  VEZIROGLU, T. B. Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1] VIBUI-ROCHAZ, L. Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VIGEBOLE, B. Bydrogen storage in magnesium powder  VIKTOROVITCH, P. Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oride layer on cells p0608 A80-46784 stransport p0608 A80-46784 stransport p0607 A80-48947 stransport p0607 A80-32922 stransport p0607 A80-46720 stransport p0604 A80-50623 stransport p0602 A80-46720 stransport p0602 A80-46720	VIEWPOINT OF ENVIRONMENTAL PROCEEDINGS  VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942]  VOSDURGH, P. B.  Vind commercialization and Alcoa Vereind Turbines  VOZOFF, E.  Electromagnetic methods in applied  VRABLE, D. L.  Design of the HTGR for process heat  W  WABREK, R. H.  Cassegrain solar concentrators for  WACHTELL, G. P.  Self controlling, self pumping heat system study [COO-4484-07]  WADE, D. T.  Exton Donor Solvent Coal Liquefacti Development Program Status  WADE, J. E.  Vegetation as an indicator of high [RLO-2227-T24-79/1]  WAGHER, C. E.  Upgraded automotive gas turbine eng development program, volume 2 [NASA-CE-159671]  WABLIG, M.	post section posts and posts are pos
VERNA, A.  Off-peak power for hydrogen product  VERNBULES, T.  Liquid fuels from biomass: Catalys conditions [LBL-9789]  VERSAW, R. F.  Study of methane fuel for subsonic aircraft [NASA-CR-159320]  VERSPURTEN, E. S. On the influence of an interfacial Au/n-Galas Schottky barrier solar  VERSTER, J. L. An emissometer with high accuracy f determination of the total hemisp emittance of surfaces  VEZIROGLU, T. M. Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1]  VIEUI-ROCHAZ, L. Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VIKTOROVINCH, P. Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VIKTOROVINCH, P. Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 for cherical p0621 A80-48947 sechnology for systems p0667 H80-32922 cogenated properties and cs p0602 A80-46720 stroperties and cs p0602 A80-46720 stroperties and cs p0602 A80-46720 stroperties and cs p0602 A80-46720 flat surfaces	VIEWPOINT OF ENVIRONMENTAL PROCEEDINGS  FINERGY/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942]  VOSBURGH, P. N. VIND COMMERCIALIZATION and Alcoa Verind Commercialization and Alcoa Verind Turbines  VOZOFF, K. Electromagnetic methods in applied  VRABLE, D. L. Design of the HTGR for process heat  W  WABREK, R. N. Cassegrain solar concentrators for  FACHTELL, G. P. Self controlling, self pumping heat system study [COO-4484-07]  WADE, D. T. Exton Donor Solvent Coal Liquefacti Development Program Status  WADE, J. R. Vegetation as an indicator of high [RLO-2227-T24-79/1]  WACHER, C. R. Upgraded automotive gas turbine eng development program; volume 2 [NASA-CR-159671]  WHLIG, M. Overview-absorption/Rankine solar contents of the contents	of the National rgy/Environment p0581 N80-2992 of the National rgy/Environment p0581 N80-2992 of tical Axis p0687 A80-5286 geophysics p0669 A80-4617 applications p0758 A80-4831 photovoltaics p0608 A80-4679 circulation p0656 N80-3295 on Process - p0677 A80-4843 wind velocity p0694 N80-2899 fine design and p0751 N80-3271 cooling program
VERNA, A.  Off-peak power for hydrogen product  VERNEULES, T.  Liquid fuels from biomass: Catalys conditions [LBL-9789]  VERSAW, R. F.  Study of methane fuel for subsonic aircraft [MASA-CE-159320]  VERSPUETEN, E. S. On the influence of an interfacial Au/n-Gals Schottky barrier solar  VERSTER, J. L.  An emissometer with high accuracy f determination of the total hemisp emittance of surfaces  VEZIROGLU, T. L.  Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1]  VIBUI-ROCHAZ, L.  Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VIGEBOLE, B. Bydrogen storage in magnesium powder  VIKTOROVITCH, P.  Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VILLARRUBIA, B.  Solar radiation incident on tilted in Barcelona, Spain	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 sor sherical p0621 A80-48947 sechnology for systems p0667 H80-32922 cogenated properties and cs p0602 A80-46720 er p0664 A80-50623 cogenated properties and cs p0602 A80-46720 flat surfaces p0625 A80-51684	VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene is and D Program [PB80-177942]  VOSDURGH, P. B. Vind commercialization and Alcoa Veriend Turbines  VOZOFF, E. Electromagnetic methods in applied  VRABLE, D. L. Design of the HTGR for process heat  W  WABREK, R. H. Cassegrain solar concentrators for  VACHTELL, G. P. Self controlling, self pumping heat system study [COO-4484-07]  WADE, D. T. Exon Donor Solvent Coal Liquefacti Development Program Status  WADE, L. E. Vegetation as an indicator of high [RLO-2227-T24-79/1]  WAGNER, C. E. Upgraded automotive gas turbine eng development program, volume 2 [NASA-CE-159671]  WABLIG, M. Overview-absorption/Rankine solar of [LBL-10770] Development of solar driven absorpt	po575 A80-5082 of the Mational rgy/Environment po581 N80-2992 ertical Axis po687 A80-5286 geophysics po669 A80-4617 applications po758 A80-4831  Photovoltaics po608 A80-4679 circulation po656 N80-3295 con Process - po677 A80-4843 wind velocity po694 N80-2899 gine design and po751 N80-3271 cooling program po640 N80-2990
VERNA, A.  Off-peak power for hydrogen product  VERNBULES, T.  Liquid fuels from biomass: Catalys conditions [LBL-9789]  VERSAW, R. F.  Study of methane fuel for subsonic aircraft [NASA-CR-159320]  VERSPURTEN, E. S. On the influence of an interfacial Au/n-Galas Schottky barrier solar  VERSTER, J. L.  An emissometer with high accuracy f determination of the total hemiss emittance of surfaces  VEZIROGLU, T. L.  Assessment of hydrogen compressor t energy storage and transmission s [ORO-5598-T1]  VIEUI-ROCHAZ, L.  Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VIEUROROVINCH, P.  Schottky barriers on sputtered hydr amorphous silicon - Photovoltaic capacitance-voltage characteristic  VILLARRUBIA, B.  Solar radiation incident on tilted in Barcelona, Spain	p0663 A80-48461 sts and reaction p0705 H80-31646 transport p0708 H80-32533 oxide layer on cells p0608 A80-46784 for cherical p0621 A80-48947 sechnology for systems p0667 H80-32922 cogenated properties and cs p0602 A80-46720 strans p0602 A80-46720 strans p0602 A80-46720 strans p0602 A80-46720 flat surfaces p0625 A80-51684 Stirling	VORIS, B.  Energy/Environment 4: Proceedings Conference on the Interagency Ene R and D Program [PB80-177942]  VORDURGH, P. B. Vind commercialization and Alcoa Vereind Turbines  VOROFF, K. Electromagnetic methods in applied  VRABLE, D. L. Design of the HTGR for process heat  WABREK, R. M. Cassegrain solar concentrators for  EACHTELL, G. P. Self controlling, self pumping heat system study [CO0-4484-07]  WADE, D. T. Exton Donor Solvent Coal Liquefacting Development Program Status  WADE, J. R. Vegetation as an indicator of high [RLO-2227-T24-79/1]  WACEER, C. E. Upgraded automotive gas turbine eng development program, volume 2 [NASA-CR-159671]  WHILG, M. Overview-absorption/Rankine solar of [IBL-10770]	po575 A80-5082 of the Mational rgy/Environment po581 N80-2992 ertical Axis po687 A80-5286 geophysics po669 A80-4617 applications po758 A80-4831  Photovoltaics po608 A80-4679 circulation po656 N80-3295 con Process - po677 A80-4843 wind velocity po694 N80-2899 gine design and po751 N80-3271 cooling program po640 N80-2990

	,
Evaluation of control strategies for solar	WATKINS, J. L. !
collector loops [181-10716] p0647 N80-31932	Dc to ac power conditioning for photovoltaic arrays and utility interfacing
Spectral character of solar and circumsolar radiation	p0605 A80-4674
[LBL-10802] p0653 N80-32916	Modeling and evaluation of designs for solid
MIBEL, B. T. Development of combustion data to utilize low-Btu	hydrogen storage beds [CONF-800616-8] 1 p0666 #80-3255
gases as industrial process fuels: Modification of flame characteristics	WATSON, K. S. Collecting fly ash from low sulphur coals: An
[DOE/ET-14851/2] p0706 N80-31659 NALD, P. V.	Overview of Australian experience p0592 N80-3393
Ion implanted solar cells from EPG silicon ribbons	WATSON, R. A.
p0601 A80-46705	Comparison with strain gage data of centrifugal stresses predicted by finite element analysis on
Working fluids for solar, Rankine-cycle cooling systems	the DOE/Sandia 17 m Darrieus turbine [SAND-79-1990] p0741 N80-2875
p0595 180-45299 Optimum working fluids for solar powered Rankine	Thermal energy storage systems using fluidized bed
Cycle cooling of buildings p0625 A80-51681	heat exchangers [NASA-CR-159868] p0775 N80-2886
Development of solar driven absorption air	WEAST, T. B.
conditioners and heat pumps [LBL-10771] p0642 N80-30925	Study of thermal energy storage using fluidized bed heat exchangers
ALEBR, G.	p0764 A80-4824
Regenerative engines with dense phase working fluids - The Malone cycle: p0734 A80-48502	WEAVER, H.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling
MALKER, G. H.	chatana fan sagidangan
Gals solar cells for space applications p0613 180-48203	[C00-4520-1] :p0632 N80-2890
WALSH, P. H.	Direct electrochemical generation of electricity
Pormation and control of fuel-nitrogen pollutants in catalytic combustion of coal-derived gases	from coal [SAN-0115-105-1] p0752 N80-3286
[FE-2762-8] p0577 N80-28557	WEBB, D. A. Nickel-cadmium batteries for the Modular Power
Intergenerational equity and conservation	Subsystem
[NASA-CB-163434] p0580 N80-29861	p0769 180-4839
Trace element characterization of coal wastes	The SWAB (Spectral Wave And Bar) program
[PB80-166150] p0577 N80-28488 HANG, C. C.	[PB80-196041] p0714 N80-3405
Thermionic topping of combined cycle powerplants and cogeneration applications	Closed-cycle gas turbines for power generation and LNG waporization
P0730 A80-48423	p0739_180-5260
Trace element characterization of coal wastes [PB80-166150] p0577 N80-28488	Progress in the development of small flame heated : thermionic energy converters
MARD, D. S. Residential solar heating and cooling using	P0732 A80-4847
evacuated tube solar collectors: CSU Solar  Bouse 3, executive summary  [COO-2858-24] p0647 N80-31941	Development of sodium sulfur batteries [BMFT-FB-T-79-60] p0776 N80-2990
[COO-2858-24] p0647 N80-31941	WREKS, K. D. Open-cycle MHD systems analysis
Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar	[EPRI-AP-1316] p0753 880-3288
house 3, executive summary	Fuel gas from used tyres by means of the
[COO-2858-24] p0647 N80-31941	Babcock-Rohrbach process p0685 A80-5003
Anatomy of regional solid waste resource recovery projects	WEGLEY, H. L.
p0574 A80-49939	Siting handbook for small wind energy conversion systems
MARIN, D.  Behavior of secondary lithium and aluminum-lithium	[PNL-2521-REV-1] p0747 N80-3094
electrodes in propylene carbonate p0774 A80-51690	Progress in the field of terrestrial solar generators
ARREN, H. L.	p0602 180-4671
Evaluation of control strategies for solar collector loops	Closed cycle MHD power plant and retrofit
[LBL-10716] p0647 N80-31932  ARRINGTOM, R. O.	optimization application p0717 A80-4423
Simulation and a preliminary comparison of passive	WEI, L. Y.
solar heating systems [ASME PAPER 80-HI-17] p0611 A80-48008	General formula for the incidence factor of a solar heliostat receiver system
ASHBURN, J. Research on Cu sub x S/(cd, Zn)S photovoltaic	p0622 A80-4975
solar energy converters [LBL-10791] p0654 N80-32927	Peat char gasification - Laboratory and PDU-scale studies
ASSON, J. A. A successful eastern in situ coal gasification	p0674 A8J-4829 Thermodynamic analysis of coal gasification
field trial p0675 A80-48342	processes p0686 A80-5121
ASZKIBNICZ, N.	WEINBERG, I.
Investigation of the feasibility of methanol as an automobile fuel	Radiation damage in high voltage silicon solar cell p0658 N80-3388
p0688 A80-52881	

Photovoltaic institutional issues study
[SAND-79-7054] p0584 N80-31550

	•
Weinberger, A. J.	WHITE, D. C.
Some etching studies of the microstructure and	Energy choices for the 1980s
composition of large aluminosilicate particles	p0570 A80-47099
in fly ash from coal-burning power plants	BHITE, G. A.
p0569 180-45481	Indirect liquefaction via the Avco coal
ERIHGART, C.  Low cost composite materials for wind energy	gasification system p0674 A80-48296
conversion systems	WHITE, H. J.
p0717 A80-44104	Mini-OTEC
BEINSTRIB, S. D.	p0740 A80-53473
Active solar energy system design practice manual	URITE, L. R.
[SOLAR/0802-79/01] p0632 N80-28889	Development of the high temperature air heater for
WRIESTOCK, I. B. Status of electrochemical energy storage systems	open cycle BBD p0724 A80-48224
for electric vehicle, solar, and electric	BHITE, M. H.
utility applications	Design, performance and life cycle cost
p0765 A80-48325	relationships for a 500kW space solar array
WEISHAW, L.	p0617 A80-48356
Ultrasonic characterization of coal liquefaction products	WHITE, R. A. Pulsed power accelerators for particle beam fusion
[DOB/PC-10346/1] p0702 N80-31503	[SAND-80-0550C] p0715 880-34239
WEISS, A. H.	WHITPIELD, B.
Kinetics and mechanisms of catalytic	Methodology for the comparative assessment of the
hydroliquefaction and hydrogasification of lignite	Satellite Power System (SPS) and alternative
[FE-2702-8] p0691 #80-28555	technologies
Rinetics and mechanisms of catalytic hydroliquefaction and hydrogasification of lignite	[HASA-CR-163049] p0750 B80-31951 BIAUX, J. P.
[PE-2702-10] p0709 H80-32556	A new rechargeable high voltage low temperature
WEIZER, V. G.	molten salt cell
Radiation damage in high voltage silicon solar cells	p0764 A80-48237
p0658 N80-33689	DICEBR, J. J.
WELDOE, W. P.	Gallium arsenide photovoltaic dense array for
A study of the applicability/compatibility of inertial energy storage systems to future space	concentrator applications [SAND-80-1569C] p0654 M80-32936
missions	Gallium arsemide photovoltaic dense array for
[NASA-CE-163584] p0777 N80-32856	concentrator applications
WENDELL, L. L.	[SAND-79-2270C] p0655 N80-32938
Wind characteristics program element	DIGGINS, D. B.
[PNL-3211] p0754 N80-33073	TIDP - Basic research for answering Plorida's residential energy conservation questions
WEBSHUTOWIS, B. F. Steam engine analysis	p0576 A80-51954
[FE-8917-2] p0743 N80-29741	NIJEYSUNDERA, B. B.
WESTE, W. H., JR.	Transient thermal behaviour of solar ronds
Peasibility studies of spoiler and aileron control	p0623 A80-50962
systems for large horizontal-axis wind turbines	NILCOX, J. P.
p0727 A80-48318	Design study of steel V-Belt CVT for electric vebicles
Hydrogen in metals - Outstanding properties and	[NASA-CR-159845] p0777 N80-32299
examples for utilization. II	WILCONSON, A. L.
p0661 A80-43642	Development of polyimide materials for use in
WERRER, R. V.	solar energy systems
The fusion-synfuel tie producing hydrogen with the Tandem Mirror Reactor	[DOE/CS-35305/T2] p0636 N80-29870
p0662 A80-48403	1979 status of the OTEC Environment Program
WERTHEIN, R. J.	p0577 180-53689
Development of molten carbonate fuel cell power	WILES, C. C.
plant technology	Municipal solid waste as an industrial fuel
[DOE/ET-15440/1] p0750 H80-31938	p0670 A80-47589
WEST, C. D. An analytical solution for a Stirling machine with	Co-firing densified refuse derived fuel in a spreader stoker fired boiler
an adiabatic cylinder	p0684 180-50018
p0734 A80-48501	WILEY, R.
WESTOR, M. W.	Hydrogen production from remote power sites
A thermal performance evaluation technique for	[BNL-27457] p0666 B80-32553
passive space heating systems p0626 A80-52627	WILKRY, H. L. Hethane recovery from urban refuse
WESTPHAL, W.	p0670 A80-47587
Satellite power systems for Western Europe -	US Department of Energy's methane from landfills
Problems and solution proposals	program
p0622 A80-50633	[CONF-7910126-1] p0701 N80-30558
WESTRA, L.	WILKINSON, W. O.
Results from study of potential early commercial  MHD power plants and from recent RTF design work	Low-cost flywheel demonstration program [DOE/ET-26931/T1] p0778 B80-32897
p0717 A80-44107	Low-cost flywheel demonstration program
WEVREKA, B. S.	[CONS-5085-T2] p0780 N80-33909
Trace element characterization of coal wastes	WILLENBERG, H. J.
[PB80-166150] p0577 N80-28488	Advanced power technology for fusion reactors
MHALE, A. V. A revised economic analysis of photovoltaic power	p0728 A80-48359 TRACT -A small fusion reactor based on near-term
modules	engineering
p0602 A80-46715	p0733 A80-48493
Silicon solar cell array technology and the	BILLIAMS, A. B.
prospects for cost reduction	The JPL parabolic dish project
p0628 A80-52861	p0618 A80-48417
WHISLER, D. J. Comparative analysis of aluminum-air battery	WILLIAMS, G. T. Seasonal thermal energy storage of chilled water
propulsion systems for passenger vehicles	in aquifers
[UCRL-52933] p0778 M80-32907	p0766 A80-48335

PERSONAL AUTHOR INDEX WILLIAMS, J. H.
Trace element Characterization of coal wastes [ PB80-166150] p0577 880-28488 WILLIAMS, K. Open-cycle MHD power conditioning and control requirements definition [ EPRI-AF-1345 ] D0752 N80-32864 WILLIAMS, O. H. Evaluation of wall temperature difference profiles for heat absorption tubes exposed nonuniformly to solar radiation D0596 A80-45319 WILLIAMS. P. A. Comparative economics of small solar thermal electric power systems Assessment of solar thermal concepts for small power systems applications n0618 480-48463 WILLIS, D. H.
Design and operation of fluidised bed industrial boilers and hot gas producers p0672 A80-48202 WILLIS, W. E.

Coal gasification/gas cleanup test facility:

Volume 1. Description and operation
[PB80-188378] p0707 N D0707 N80-31990 WILLMER, A. C. Wind tunnel tests on a 3 m diameter Musgrove windmill. D0737 A80-50943 Gallium arsenide solar cells for use in concentrated sunlight p0628 A80-52864 WILSON, D. C.
The efficiency of recovering energy and materials from solid waste D0574 A80-49933 Simplified energy design economics: Principles of economics applied to energy conservation and solar energy investments in buildings [PB80-179245] p0634 N80-2955 D0634 N80-29534 WILSON, J. I. B. Amorphous silicon solar cells n0628 A80-52863 WINEE, D. B.

Energy conservation in terminal airspace through
fuel consumption modeling
[SAE PAPER 800745] p0573 A80-4 p0573 A80-49695 WINGBOVE, R. D. A revised economic analysis of photovoltaic power modules p0602 A80-46715 The tax on waste heat - An instrument of economic policy for preserving resources p0569 A80-44764 The kinetics of the 02/CO2 reaction in molten carbonate - Beaction orders for O2 and CO2 on NiO p0726 180-48284 WINSTON, B. Fundamentals and techniques of nonimaging optics for solar energy concentration [DOE/EB-04657/2] D0652 N80-32896 WIRTE, G. P.
Fuel cell applied research: Electrocatalysis and material [BNL-51072] .D0744 N80-29885 MISE, D. L. Peasibility of a peat biogasification process p0669 A80-46197 Status of peat biogasification development P0674 A80-48293 Liquid fuels production from biomass [COO-4388-10] p0708 N80-32545 Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst

[PE-3240-T4] p0692 N6
Shift conversion and methanation in coal

gasification: Bench-scale evaluation of a sulfur resistant catalyst

[FE-3240-T5]

p0692 N80-28561

p0696 880-29509

[ARI-BP-43]

MISE, J. P. Requirements for future Air Porce satellite solar power technology p0604 A80-46736 DISER, W. A. Applied research and evaluation of process concepts for liquefaction and gasification of western coals n0691 N80-28558 FE-2006-161 Applied research and evaluation of process concepts for liquefaction and gasification of western coals [FE-2006-17] WITTENBERG, L. J. Management of a large, operational solar pond RITTERR, V.
Fluorescent planar concentrators - Performance and experimental results p0604 A80-46741 PORRHER, J. J. Integrated Cu2S-CdS thin film solar cell generator HOLPP. B. Capital formation for small wind energy conversion system manufacturers: A guide to methods and sources [ SEBI/TR-98298-1] p0751 N80-32462 BOLPP, P. M. Thermal resource availability p0718 A80-44603 WOLOWSKI, E. Status of coal hydrogenation outside Europe p0669 A80-45513. Preliminary comparative assessment of land use for the Satellite Power System (SPS) and alternative electric energy technologies [NSA-CR-163327] p0580 N80-298 p0580 N80-29886 Methodology for the comparative assessment of the Satellite Power System (SPS) and alternative technologies [ NASA-CR- 1630491 p0750 N80-31951 PONG. C. B. Use of an automated mass spectrometer for an underground coal gasification field test p0709 N80-32565 [UCRL-84366] C. P. C. High-temperature thermochemical water splitting cycle fusion reactor design considerations D0663 A80-48449 Terrestrial photovoltaic power systems with sunlight concentration [SAND-80-7008] Shift conversion and methanation in coal gasification: Bench-scale evaluation of a [ FE-3240-T4] r0692 N80-28561 Shift conversion and methanation in coal gasification: Bench-scale evaluation of a sulfur resistant catalyst [FE-3240-T5] p0696 N80-29509 WOOD, J. G.
Stirling engines for developing countries
p073 p0732 180-48454 WOOD, S. G. Sorption properties of sediments and energy-related pollutants
[FB80-189574] p0
WOODCOCK, W. G., III
Multi-hundred kW solar arrays for space p0589 N80-32997 p0617 A80-48355 WOODRUFF. G. L DRUFF, G. L.

Scoping study of a tandem-mirror fusion reactor coupled to a thermochemical hydrogen synfuel plant p0662 A80-48406 WOOLSEY, H. P. Chemistry of lignite liquefaction
[FE-2211-11] p0704

\*\*ROBEROVEN, B. H.
Concentrating solar collector test results p0704 N80-31642 [SAND-86-0801C] p0633 N80-28912 HORREGUDT, J. Characterization of open-cycle, coal-fired MHD generators

p0750 N80-31936

#### PERSONAL AUTHOR INDEX

Characterization of open-cycle, coal-fired MHD	
	TANG, J. J.
generators	Advanced photovoltaic concentrator cells
[ARI-RP-46] p0751 880-32234	[DSE-4042-T40] p0645 N80-3190
HORONOFF, A.	TAIG, J. J. J.
The investment needs of the coal industry of the	Thin films of InP for photovoltaic energy conversio
European Community	[COO-3004-2] p0642 #80-3091
p0573 A80-49399	TER, J. H.
BORSTELL, J. H.	AlSh as a potential photovoltaic material
Mechanisms of mitrogen heterocycle influence on	p0608 A80-4678
turbine fuel stability	Reactively sputtered thin film cu/sub x/S/CdS
p0695 N80-29327	photovoltaic devices
WORTHINGTON, P. J.	[UCID-18592] p0637 H80-2987
Large-scale electrical energy storage	YELON, W. B.
p0761 A80-44241	Structure of anorphous silicon and silicon hydrides
BOUK, V.	p0599 180-4664
Efficiency of coal use, electricity for RVs versus synfuels for ICEs	TECHAN, P. A. Collector sealants and breathing
[SAE PAPER 800109] p0680 A80-49727	[DOB/CS-15362/1] p0650 N80-3252
'Biberonnage' makes an electric car practical with	TRON. 1. 1.
existing batteries	Open-circuit voltage of induced-junction solar cell
[SAE PAPER 800204] p0773 A80-49731	p0622 A80-5075
WRAY, W. O.	YEP; T. O.
Trombe wall we direct gain - A comparative	Operation of multi-bandgap concentrator cells with
analysis of passive solar heating systems	a spectrum splitting filter
p0626 A80-52828	p0604 A80-4674
A semi-empirical method for estimating the	TIBER, B.
performance of direct gain passive solar heated	Transient thermal analysis of phase change thermal
buildings	energy storage systems
p0627 A80-52838	[ASME PAPER 80-HT-2] p0762 A80-4800
WRIGHT, J. D.	YINGST, A.
Analytical modeling of line focus solar collectors	Photovoltaic applications definition and
[SERI/TP-333-591] p0647 #80-31926	photovoltaic system definition study in the
WRIGHT, J. K.	agricultural sector. Volume 2: Technical results
Large-scale electrical energy storage	[SAND-79-7018/2-VOL-2] p0586 M80-3287
p0761 A80-44241	Photovoltaic applications definition and
WRIGHT, T. P.	photovoltaic system definition study in the
Grad B focusing and deposition of relativistic	agricultural sector. Volume 3. Appendixes
electron beams	[SAND-79-7018/3] p0652 N80-3289
Theoretical sultiple beam overlap from channel	Average chemical structure of mild hydrogenolysis
transport of intense particle beams	products of coals
p0735 A80-49067	p0679 180-4962
Relativistic-electron-beam/target interaction in	TOSHIHOTO, H.
plasma channels	Hydrogen production by the GA sulfur-iodine process
p0735 A80-49068	[GA-A-15777-REV] p0666 N80-3165
WRIGLEY, C.	YOUNG, D. C.
Pilot line report: Development of a high	Investigation of mechanisms of hydrogen transfer
efficiency thin silicon solar cell	
	in coal hydrogenation
[NASA-CR-163522] p0644 N80-31876	[PR-2305-33] p0697 880-2951
[MASA-CR-163522] p0644 M80-31876	[PE-2305-33] p0697 N80-2951 Investigation of mechanisms of hydrogen transfer
[HASA-CR-163522] p0644 H80-31876 HU. J. On the selection of working fluids for OTEC power	[PR-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2
[NASA-CR-163522] p0644 H80-31876 WU. J. On the selection of working fluids for OTEC power plants	[PR-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PR-2305-30] p0710 H80-3256
[NASA-CR-163522] p0644 H80-31876  WU. J. On the selection of working fluids for OTEC power plants  p0738 A80-50946	[FE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 H80-3256 YOUNG, G. L.
[NASA-CR-163522] p0644 H80-31876 WU, J. On the selection of working fluids for OHEC power plants p0738 A80-50946 WURRHANN, K. A.	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256 YOUNG, G. L. Automated multi-sample gas chromatographic
[NASA-CR-163522] p0644 H80-31876 WU, J. On the selection of working fluids for OTEC power plants p0738 A80-50946 WURRMANN, K. A. Steps to system analysis in waste management	[PR-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PE-2305-30] p0710 H80-3256 TOUNG, G. L. Automated multi-sample gas chromatographic analysis of fossil fuel gases
[NASA-CR-163522] p0644 H80-31876 WU, J. On the selection of working fluids for OTEC power plants p0738 A80-50946 WURRHAWN, K. A. Steps to system analysis in waste management p0574 A80-49932	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256 YOUNG, G. L. Automated multi-sample gas chromatographic analysis of fossil fuel gases [BLE-2721] p0702 #80-3150
[NASA-CR-163522] p0644 H80-31876 WU, J. On the selection of working fluids for OTEC power plants p0738 A80-50946 WUMBHANN, K. A. Steps to system analysis in waste management p0574 A80-49932 WYMAN, C. A review of collector and energy storage	[PR-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PE-2305-30] p0710 H80-3256 TOUNG, G. L. Automated multi-sample gas chromatographic analysis of fossil fuel gases
[NASA-CR-163522] p0644 H80-31876 WU, J. On the selection of working fluids for OTEC power plants p0738 A80-50946 WUMBHANN, K. A. Steps to system analysis in waste management p0574 A80-49932 WYMAN, C. A review of collector and energy storage	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  ***YOUNG, G. L. Automated multi-sample gas chromatographic analysis of fossil fuel gases [MLH-2721] p0702 #80-3150  ***YOUNG, M. B. B.
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants p0738 A80-50946  WUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAMB, C. A review of collector and energy storage technology for intermediate temperature applications	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  ***YOUNG, G. L. Automated multi-sample gas chromatographic analysis of fossil fuel gases [MLH-2721] p0702 #80-3150  ***********************************
[NASA-CR-163522] p0644 H80-31876 WU. J. On the selection of working fluids for OTEC power plants p0738 A80-50946 WURBHANN, K. A. Steps to system analysis in waste management p0574 A80-49932 WYMAN, C. A review of collector and energy storage technology for intermediate temperature applications p0595 A80-45311	[PR-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PR-2305-30] p0710 H80-3256  **NOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLR-2721] p0702 H80-3150  **YOUNG, H. B.  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429  Technology Assessment. Citations from the HTIS
[NASA-CR-163522] p0644 H80-31876 WO, J. On the selection of working fluids for OTEC power plants p0738 A80-50946 WURRHANN, K. A. Steps to system analysis in waste management p0574 A80-49932 WYMAN, C. A review of collector and energy storage technology for intermediate temperature applications p0595 A80-45311	[FE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 H80-3256  **TOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [BLH-2721] p0702 H80-3150  **YOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429  Technology Assessment. Citations from the HTIS data base
[NASA-CR-163522] p0644 H80-31876 WU, J. On the selection of working fluids for OHEC power plants p0738 A80-50946 WUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932 WYHAM, C. A review of collector and energy storage technology for intermediate temperature applications p0595 A80-45311 WYMME, P. E. Research and development of an advanced process	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  ***MOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [BLR-2721] p0702 #80-3150  ***MOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [FB80-813173] p0783 #80-3430
[NASA-CR-163522] p0644 H80-31876 WU. J. On the selection of working fluids for OTEC power plants p0738 A80-50946 WURRHAWS, K. A. Steps to system analysis in waste management p0574 A80-49932 WYMAE, C. A review of collector and energy storage technology for intermediate temperature applications p0595 A80-45311 WYWEE, F. R. Research and development of an advanced process for conversion of coal to synthetic gasoline and	[PE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PE-2305-30] p0710 H80-3256  **TOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLM-2721] p0702 H80-3150  **YOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429  **Technology Assessment. Citations from the HTIS data base [PB80-813173] p0783 H80-3430  **YOUNG, M. P.
[NASA-CR-163522] p0644 H80-31876 WU. J. On the selection of working fluids for OHEC power plants p0738 A80-50946 WURRHANS, K. A. Steps to system analysis in waste management p0574 A80-49932 WYMAE, C. A review of collector and energy storage technology for intermediate temperature applications p0595 A80-45311 WYNNE, F. E. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels	[PR-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PE-2305-30] p0710 H80-3256  **TOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLM-2721] p0702 H80-3150  **YOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429  Technology Assessment. Citations from the HTIS data base [PB80-813173] p0783 H80-3430  **YOUNG, H. P.  Solar domestic hot water system, a comparative
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAM, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMME, P. E. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  ***YOUNG, G. L.** Automated multi-sample gas chromatographic analysis of fossil fuel gases [MLH-2721] p0702 #80-3150  ****YOUNG, M. B.** Technology Assessment. Citations from the HTIS data base [FE80-813165] p0783 #80-3429  ****Technology Assessment. Citations from the HTIS data base [FE80-813173] p0783 #80-3430  **********************************
[NASA-CR-163522] p0644 H80-31876  WO, J. On the selection of working fluids for OTEC power plants  p0738 A80-50946  WURRHAWE, K. A. Steps to system analysis in waste management p0574 A80-49932  WYMAE, C. A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  WYMBE, P. B. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOCKI, B.	[FE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 H80-3256  **NOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLE-2721] p0702 H80-3150  **YOUNG, H. B.  Technology Assessment. Citations from the HTIS data base [FB60-813165] p0783 H80-3429  Technology Assessment. Citations from the HTIS data base [PB60-813173] p0783 H80-3430  **YOUNG, H. F.  Solar domestic hot water system, a comparative study and storage tank investigation p0643 H80-3186
[NASA-CR-163522] p0644 H80-31876 WU. J. On the selection of working fluids for OHEC power plants p0738 A80-50946 WURRHAMS, K. A. Steps to system analysis in waste management p0574 A80-49932 WYMAS, C. A review of collector and energy storage technology for intermediate temperature applications p0595 A80-45311 WYMBS, P. E. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels [PE-1800-45] p0704 H80-31641 WYSOCKI, B. DEROB - A system for simulating the dynamic energy	[PR-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PE-2305-30] p0710 H80-3256  **TOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLM-2721] p0702 H80-3150  **YOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429  Technology Assessment. Citations from the HTIS data base [PB80-813173] p0783 H80-3430  **YOUNG, B. P.  Solar domestic hot water system, a comparative study and storage tank investigation p0643 H80-3186
[NASA-CR-163522] p0644 H80-31876  WU. J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAM, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMBE, P. E. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 R80-31641  WYSOCKI, B. DEBOB - A system for simulating the dynamic energy performance of passive solar structures	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **NOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [MLH-2721] p0702 #80-3150  **YOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FE80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [FE80-813173] p0783 #80-3430  **YOUNG, B. P.  Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **YOUNG, S. K. Photovoltaic applications definition and
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OTEC power plants  p0738 A80-50946  WUHRHAWE, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAE, C. A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  WYMBE, P. R. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASBE PAPER 80-HT-21] p0612 A80-48011	[FE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 H80-3256  **NOUNG, G. L.*  Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLR-2721] p0702 H80-3150  **YOUNG, H. B.*  Technology Assessment. Citations from the HTIS data base [FB60-813165] p0783 H80-3429  Technology Assessment. Citations from the HTIS data base [FB60-813173] p0783 H80-3430  **YOUNG, H. P.*  Solar domestic hot water system, a comparative study and storage tank investigation  p0643 H80-3186  **YOUNG, S. K.*  Photovoltaic applications definition and photovoltaic system definition study in the
[NASA-CR-163522] p0644 H80-31876  WO, J. On the selection of working fluids for OTEC power plants  p0738 A80-50946  WURRHAMS, K. A. Steps to system analysis in waste management p0574 A80-49932  WYMAE, C. A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  WYMBE, P. B. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASHE PAPRE 80-HI-21] p0612 A80-48011  WYSS. P. J.	[PR-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [PE-2305-30] p0710 H80-3256  **TOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLR-2721] p0702 H80-3150  **YOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429  **Technology Assessment. Citations from the HTIS data base [PB80-813173] p0783 H80-3430  **YOUNG, H. P.  Solar domestic hot water system, a comparative study and storage tank investigation p0643 H80-3186  **YOUNG, S. K. Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OTEC power plants  p0738 A80-50946  WUHRHAWE, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAE, C. A review of collector and energy storage technology for intermediate temperature applications  p0595 A80-45311  WYMBE, P. R. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASBE PAPER 80-HT-21] p0612 A80-48011	[FE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 H80-3256  **NOUNG, G. L.*  Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLR-2721] p0702 H80-3150  **YOUNG, H. B.*  Technology Assessment. Citations from the HTIS data base [FB60-813165] p0783 H80-3429  Technology Assessment. Citations from the HTIS data base [FB60-813173] p0783 H80-3430  **YOUNG, H. P.*  Solar domestic hot water system, a comparative study and storage tank investigation  p0643 H80-3186  **YOUNG, S. K.*  Photovoltaic applications definition and photovoltaic system definition study in the
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAM, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-49311  WYMBE, P. E. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPRE 80-HI-21] p0612 A80-48011  WYSS, P. J. Energy recycling through refuse pelletizing p0683 A80-50008	[FE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 H80-3256  **TOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLE-2721] p0702 H80-3150  **YOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429  Technology Assessment. Citations from the HTIS data base [FB80-813173] p0783 H80-3430  **YOUNG, M. F.  Solar domestic hot water system, a comparative study and storage tank investigation p0643 H80-3186  **YOUNG, S. K.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-V01-2] p0586 H80-3287  Photovoltaic applications definition and photovoltaic system definition study in the
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WUHRHANN, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAN, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYNNE, F. B. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels [FE-1800-45] p0704 R80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPEE 80-BI-21] p0612 A80-48011  WYSS, F. J. Energy recycling through refuse pelletizing	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **MOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [BLR-2721] p0702 #80-3150  **MOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FE80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [PE80-813173] p0783 #80-3430  **MOUNG, B. P.  Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **MOUNG, S. K. Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 #80-3287 Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes
[NASA-CR-163522] p0644 H80-31876  WO, J. On the selection of working fluids for OTEC power plants  P0738 A80-50946  WUHRHAWE, K. A. Steps to system analysis in waste management p0579 A80-49932  WYMAE, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMBE, P. E. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASHE PAPER 80-HT-21] p0612 A80-48011  WYSS, P. J. Energy recycling through refuse pelletizing p0683 A80-50008	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **NOUNG, G. L.  Automated multi-sample gas chromatographic analysis of fossil fuel gases [MLR-2721] p0702 #80-3150  **YOUNG, M. B.  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [FB80-813173] p0783 #80-3430  **YOUNG, M. F.  Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **YOUNG, S. K.  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SMND-79-70182-VOL-2] p0586 #80-3287  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SMD-79-7018/3] p0652 #80-3289
[NASA-CR-163522] p0644 H80-31876  WO, J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WORRHANN, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAN, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYHEE, P. R. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASHE PAPER 80-HT-21] p0612 A80-48011  WYSS. P. J. Energy recycling through refuse pelletizing p0683 A80-50008	[FE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 H80-3256  **MOUNG, G. L.** Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLE-2721] p0702 H80-3150  **MOUNG, H. B.** Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429  **Technology Assessment. Citations from the HTIS data base [FB80-813173] p0783 H80-3429  **Technology Assessment. Citations from the HTIS data base [FB80-813173] p0783 H80-3430  **MOUNG, H. F.** Solar domestic hot water system, a comparative study and storage tank investigation p0643 H80-3186  **MOUNG, S. K.** Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-V01-2] p0586 H80-3287  **Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 H80-3289  **MOUSEPIAN, V.**
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAM, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-49311  WYMME, P. B. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels [PE-1800-45] p0704 R80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPEE 80-B1-21] p0612 A80-48011  WYSS, P. J. Energy recycling through refuse pelletizing p0683 A80-50008  Y  YAMAGIWA, A. T. Wind resource assessment in the upper Skagit River	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **MOUNG, G. L.*  Automated multi-sample gas chromatographic analysis of fossil fuel gases [BLE-2721] p0702 #80-3150  **MOUNG, M. B.*  Technology Assessment. Citations from the HTIS data base [FE80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [PE80-813173] p0783 #80-3430  **MOUNG, B. P.*  Solar domestic hot water system, a comparative study and storage tank investigation  **POUNG, S. K.*  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-V01-2] p0586 #80-3287  **Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAKD-79-7018/3]  **POUSEPIAB.** Volume 3. Appendixes [SAKD-79-7018/3]  **POUSEPIAB.** Volume 2: Coal-fired HED
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OTEC power plants  P0738 A80-50946  WUHRHAWE, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAE, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMBE, P. E. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASHE PAPER 80-HT-21] p0612 A80-48011  WYSS, P. J. Energy recycling through refuse pelletizing p0683 A80-50008  Y  YAMAGIWA, A. T. Wind resource assessment in the upper Skagit River valley of Washington	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **NOUNG, G. L.*  Automated multi-sample gas chromatographic analysis of fossil fuel gases [BLR-2721] p0702 #80-3150  **YOUNG, M. B.*  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [FB80-813173] p0783 #80-3430  **YOUNG, M. F.*  Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **YOUNG, S. K.*  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAMD-79-7018/2-VOL-2] p0586 #80-3287  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAMD-79-7018/3] p0652 #80-3289  **YOUNGFIAM, V.*  Characterization of open-cycle, coal-fired HED generators
[NASA-CR-163522] p0644 H80-31876  WO, J. On the selection of working fluids for OHC power plants  P0738 A80-50946  WORRHANN, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAN, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WINDE, P. R. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WISOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASHE PAPER 80-HT-21] p0612 A80-48011  WYSS., P. J. Energy recycling through refuse pelletizing p0683 A80-50008  Y  VAHAGINA, A. T. Wind resource assessment in the upper Skagit River Valley of Washington	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **MOUNG, G. L. Automated multi-sample gas chromatographic analysis of fossil fuel gases [MLE-2721] p0702 #80-3150  **MOUNG, H. B. Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 #80-3429  **Technology Assessment. Citations from the HTIS data base [FB80-813173] p0783 #80-3430  **MOUNG, M. P. Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **YOUNG, S. E. Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAMD-79-7018/2-V01-2] p0586 #80-3287  **Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAED-79-7018/3] p0652 #80-3289  **WOUSEPIAM, V. Characterization of open-cycle, coal-fired HED generators [AEI-EP-43] p0750 #80-3193
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAM, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMME, P. B. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels [PE-1800-45] p0704 R80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPER 80-BI-21] p0612 A80-48011  WYSS, P. J. Energy recycling through refuse pelletizing p0683 A80-50008  V  YAMAGIWA, A. T. Wind resource assessment in the upper Skagit River Valley of Washington p0675 A80-48319	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **NOUNG, G. L.* Automated multi-sample gas chromatographic analysis of fossil fuel gases [BLR-2721] p0702 #80-3150  **YOUNG, M. B.* Technology Assessment. Citations from the HTIS data base [FE80-813165] p0783 #80-3429 Technology Assessment. Citations from the HTIS data base [PE80-813173] p0783 #80-3430  **YOUNG, B. P.* Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **YOUNG, S. K.* Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-V01-2] p0586 #80-3287 Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAED-79-7018/3]  **YOUSEPIAB. V.* Characterization of open-cycle, coal-fired HED generators [AEI-HP-43] p0750 #80-3193 Characterization of open-cycle, coal-fired HED
[NASA-CR-163522] p0644 H80-31876  WO, J. On the selection of working fluids for OTEC power plants  P0738 A80-50946  WOHERANE, K. A. Steps to system analysis in waste management p0574 A80-49932  WYMAE, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMBE, P. B. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels [PE-1800-45] p0704 N80-31641  WYSOCKI, M. DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASHE PAPEE 80-HI-21] p0612 A80-48011  WYSS, P. J. Energy recycling through refuse pelletizing p0683 A80-50008  Y  YAMAGIWA, A. T. Wind resource assessment in the upper Skagit River Valley of Washington  P0675 A80-48319  YARG, C. Y. Fuel cell applied research: Electrocatalysis and	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **NOUNG, G. L.*  Automated multi-sample gas chromatographic analysis of fossil fuel gases [BLR-2721] p0702 #80-3150  **YOUNG, M. B.*  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [FB80-813173] p0783 #80-3430  **YOUNG, M. F.*  Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **YOUNG, S. K.*  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAMD-79-7018/2-VOL-2] p0586 #80-3287  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAMD-79-7018/3] p0652 #80-3289  **YOUNGFIAM, V.*  Characterization of open-cycle, coal-fired HHD generators [ARI-RP-43] p0750 #80-3193  Characterization of open-cycle, coal-fired HHD generators
[NASA-CR-163522] p0644 H80-31876  WO, J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WURRHANN, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAN, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMBE, P. R. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  WYSS. P. J. Energy recycling through refuse pelletizing p0683 A80-50008  Y  YAMAGIWA, A. T. Wind resource assessment in the upper Skagit River Valley of Washington  p0675 A80-48319  YARG, C. I. Puel cell applied research: Electrocatalysis and materials	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **YOUNG, G. L.*  Automated multi-sample gas chromatographic analysis of fossil fuel gases [MLH-2721] p0702 #80-3150  **YOUNG, M. B.*  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [PB80-813173] p0783 #80-3430  **YOUNG, M. F.*  Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **YOUNG, S. E.*  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAMD-79-7018/2-VOL-2] p0586 #80-3287  **Photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAMD-79-7018/3] p0652 #80-3289  **YOUNGFFIAM, V.*  Characterization of open-cycle, coal-fired HHD generators [ART-RP-43] p0750 #80-3193  Characterization of open-cycle, coal-fired HHD generators [ART-RP-46] p0751 #80-3223
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAM, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMME, F. B. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels [FE-1800-45] p0704 R80-31641  WYSOCKI, B. DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASME PAPEE 80-BI-21] p0612 A80-48011  WYSS, F. J. Energy recycling through refuse pelletizing p0683 A80-50008  V  YAMAGIWA, A. T. Wind resource assessment in the upper Skagit River Valley of Washington  P0675 A80-48319  YARG, C. I. Fuel cell applied research: Electrocatalysis and Baterials [BHL-51072] P0744 880-29885	[FE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 H80-3256  HOUNG, G. L. Automated multi-sample gas chromatographic analysis of fossil fuel gases [BLR-2721] p0702 H80-3150  HOUNG, M. B. Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429 Technology Assessment. Citations from the HTIS data base [PB80-813173] p0783 H80-3430  HOUNG, B. P. Solar domestic hot water system, a comparative study and storage tank investigation p0643 H80-3186  HOUNG, S. K. Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-V01-2] p0586 H80-3287 Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAED-79-7018/3]  HOUSEPIAB, V. Characterization of open-cycle, coal-fired HED generators [AEI-HP-43] p0750 H80-3193 Characterization of open-cycle, coal-fired BED generators [AEI-HP-46] p0751 H80-3223
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants  BUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYMAE, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMBE, P. B. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels [PE-1800-45] p0704 N80-31641  WYSOCKI, M. DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASHE PAPEE 80-HI-21] p0612 A80-48011  WYSS, P. J. Energy recycling through refuse pelletizing p0683 A80-50008  Y  YAHAGIWA, A. T. Wind resource assessment in the upper Skagit River Valley of Washington  P0675 A80-48319  YANG, C. Y. Fuel cell applied research: Electrocatalysis and materials [BHL-51072] p0744 880-29885	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **YOUNG, G. L.*  Automated multi-sample gas chromatographic analysis of fossil fuel gases [MLH-2721] p0702 #80-3150  **YOUNG, M. B.*  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [PB80-813173] p0783 #80-3429  **YOUNG, M. F.*  Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **YOUNG, S. E.*  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAMD-79-7018/2-VOL-2] p0586 #80-3287  **Photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAMD-79-7018/3] p0652 #80-3289  **YOUNGFFIAM, V.*  Characterization of open-cycle, coal-fired HHD generators [ART-RP-43] p0750 #80-3193  Characterization of open-cycle, coal-fired HHD generators [ART-RP-46] p0751 #80-3223
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants  P0738 A80-50946  WUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYHAM, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYWER, P. E. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels  [PE-1800-45] p0704 H80-31641  WYSOCKI, M. DEROB - A system for simulating the dynamic energy performance of passive solar structures  [ASME PAPER 80-HT-21] p0612 A80-48011  WYSS, P. J. Energy recycling through refuse pelletizing p0683 A80-50008  Y  YAMAGIWA, A. T. Wind resource assessment in the upper Skagit River valley of Washington  P0675 A80-48319  YARG, C. I. Puel cell applied research: Electrocatalysis and materials  [BHL-51072] p0744 H80-29885  IARG, E. T. Advanced photovoltaic concentrator cells	[FE-2305-33] p0697 #80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 #80-3256  **YOUNG, G. L.*  Automated multi-sample gas chromatographic analysis of fossil fuel gases [MLH-2721] p0702 #80-3150  **YOUNG, M. B.*  Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 #80-3429  Technology Assessment. Citations from the HTIS data base [PB80-813173] p0783 #80-3430  **YOUNG, M. F.*  Solar domestic hot water system, a comparative study and storage tank investigation p0643 #80-3186  **YOUNG, S. E.*  Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAHD-79-7018/2-VOL-2] p0586 #80-3287  **Photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAHD-79-7018/3] p0652 #80-3289  **YOUSEFFIAM, V.*  Characterization of open-cycle, coal-fired HHD generators [ART-HP-43] p0750 #80-3193  Characterization of open-cycle, coal-fired BHD generators [ART-HP-45] p0751 #80-3223  **YOUSEFFIAM, V.*  Characterization of open-cycle, coal-fired BHD generators [ART-HP-46] p0751 #80-3223
[NASA-CR-163522] p0644 H80-31876  WU, J. On the selection of working fluids for OHEC power plants  BUHRHAMM, K. A. Steps to system analysis in waste management p0574 A80-49932  WYMAE, C. A review of collector and energy storage technology for intermediate temperature applications  P0595 A80-45311  WYMBE, P. B. Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels [PE-1800-45] p0704 N80-31641  WYSOCKI, M. DEROB - A system for simulating the dynamic energy performance of passive solar structures [ASHE PAPEE 80-HI-21] p0612 A80-48011  WYSS, P. J. Energy recycling through refuse pelletizing p0683 A80-50008  Y  YAHAGIWA, A. T. Wind resource assessment in the upper Skagit River Valley of Washington  P0675 A80-48319  YANG, C. Y. Fuel cell applied research: Electrocatalysis and materials [BHL-51072] p0744 880-29885	[FE-2305-33] p0697 H80-2951 Investigation of mechanisms of hydrogen transfer in coal hydrogenation, phase 2 [FE-2305-30] p0710 H80-3256  NOUNG, G. L. Automated multi-sample gas chromatographic analysis of fossil fuel gases [HLR-2721] p0702 H80-3150  NOUNG, M. B. Technology Assessment. Citations from the HTIS data base [FB80-813165] p0783 H80-3429 Technology Assessment. Citations from the HTIS data base [FB80-813173] p0783 N80-3430  NOUNG, M. F. Solar domestic hot water system, a comparative study and storage tank investigation p0643 H80-3186  NOUNG, S. K. Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 2: Technical results [SAND-79-7018/2-VOL-2] p0586 H80-3287 Photovoltaic applications definition and photovoltaic system definition study in the agricultural sector. Volume 3. Appendixes [SAND-79-7018/3] p0652 H80-3289  NOUSEFIAN, V. Characterization of open-cycle, coal-fired HHD generators [ARI-RP-43] p0750 H80-3193 Characterization of open-cycle, coal-fired HHD generators [ARI-RP-46] p0751 H80-3223  NOUSEFIAN, J. Adapting geothermal energy to produce ethanol for

the design, application benefits, and economics of energy-efficient motors - A technological update p0571 A80-47592 Use of geothermal energy in the eastern United States p0685 A80-50908 YURCHAK, S. Mobil methanol-to-gasoline process p0677 A80-48384 ZABORSZKY, J. Basic Research in Engineering: Process and Systems Dynamics and Control. High Priority Research Needs Relevant to Energy [FE-2468-65] p0590 N80-33167 Solar cells for terrestrial applications p0611 A80-47156 Solar selective black cobalt - Preparation, structure, and thermal stability p0609 A80-46933 Investigation of temperature regime of single-story house with solar heating system p0611 A80-47162 Investigation of the service life of aluminum mirrors on metal substrates at high temperatures p0611 A80-47158 Besults from study of potential early commercial
MHD power plants and from recent ETF design work
p0717 180-44107 ZAREBSKI, D. R., JR.
Operation and maintenance cost data for
residential photovoltaic modules/panels
[NASA-CR-163585] p0650 N80-32855 ZARNOČH, K. P. Heat storage capability of a rolling cylinder using Glauber's salt p0773 A80-50945 Fluorescent planar concentrators - Performance and experimental results p0604 180-46741 Advanced photovoltaic concentrator cells [DSB-4042-130] p0643 880-30946 Advanced photovoltaic concentrator cells [DSE-4042-T40] p0645 N80-31904 ZENER, C. Design of land-based, foam OTEC plants for bottoming cycles [CONF-790631-17] D0742 N80-28913 ZIEGLER, B. J. Satellite Power Systems (SPS) cost review [ DOB/TIC-11190 ] - p0654 N80-32928 ZIGNANI, P. Effect of laser irradiation on the characteristics of implanted layers for silicon solar cells p0602 A80-46711 ZIMBRHAN, R. E. Methane recovery from urban refuse p0670 A80-47587 ZIMMERNAN, W. P.

Realth requirements for advanced coal extraction systems [NASA-CR-163625] p0714 N80-34093 ZIMMBBMBYBB, G. The CO2 problem from the viewpoint of geoecology

solar power satellites - The ionospheric connection

magnetoplasma compressor with an explosion-driven

Potential of spark ignition engine, effect of vehicle design variables on top speed,

p0575-A80-50822

p0757 A80-46397

p0586 #80-32736

and energy economy

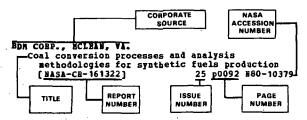
magnetic power generator

performance, and fuel economy [PB80-191836]

EUGRAVEL, M. Investigation of the feasibility of methanol as an automobile fuel p0688 A80-52881 Advanced power technology for fusion reactors p0728 A80-48359 ZURIDINGRR. R. M. Pollutants from synthetic fuels production: Coal gasification screening test results p0707 N80-31986 [PE80-182769]

ABROJET ENERGY CONSERVATION CO., SACRAMENTO, CALIF.

#### Typical Corporate Source Index Listing



The title of the document is used to provide a brief description of the subject matter. The issue, page number and NASA or AIAA accession number are included in each entry to assist the user in locating the abstract in the abstract section of an individual supplement of Energy. If applicable, a report number is also included as an aid in identifying the document.

S INTERNATIONAL SOLAR POWER CO. LTD., GENTOPTE (DENHARK) Peasibility study on a solar house heating run-6696-EN] p0655 880-32939 [EUR-66-66-EN] p0655 880-3

ACUREX CORP., MOUNTAIN VIRW, CALIF.

Pilot scale combustion evaluation of waste and alternate fuels, phase 3

[PB80-177413] p0702 880-3 [PB80-177413] p0702 N80-30952
Design, construction, and operation of a 150 kW solar-powered irrigation facility, phase 2 [ALO-4159-1] p0645 N80-31903 Air Pollution control device configurations [PB80-193253] p0593 N80-33972 Assessment of H2S control technologies for geothermal power plants [PB80-193709] p0593 N80-33973 AD-BY INTERNATIONAL, PORTOLA VALLEY, CALIP. Experimental studies of some regularities in the underground gasification of inclined coal seams [UCRL-TRANS-11565]
ADVANCED HECHANICAL TECHNOLOGY, INC., DEWTON, MASS. Design and development of Stirling engines for stationary power generation applications in the 500 to 3000 horsepower range [DOE/ET-15207/T1] p0752 880-3 [DOB/ET-15207/T1] p0752 880-32723
ADVISORY GROUP FOR AEROSPACE RESEARCH AND
DEVELOPMENT, HEUILLY-SUR-SKINE (FRANCE).
Ceramics for turbine engine applications
[AGARD-CD-2763] [AGARD-CP-276] p0743 N80-29342 AEG-TELEFURKER, HEILBROBN (WEST GERMAN).
Aspects of large area and thin silicon solar cell technologies p0658 N80-33884

Comparison of silicon solar cell characteristics at operating temperature after electron irradiation

p0659 N80-33890

ARG-TRLEFUMERS, WEDRL (WEST GERMANY).

Potential use of terrestrial photovoltaics for future space solar arrays

p0658 N80-33882

ARRODYNE RESEARCH, INC., BEDFORD, MASS.
Characterization of open-cycle, coal-fired MHD D0750 N80-31936

[ARI-RP-431 Characterization of open-cycle, coal-fired MHD generators

[ARI-RP-46] D0751 N80-32234 Study of gelled ING
[DOE/EV-02057/T2] p0695 N80-2
ARROMAUTICAL RESEARCH INST. OF SWEDEN, STOCKHOLM. p0695 N80-29506 Combined effects of periodic and stochastic loads on the fatigue of wind turbine parts, part 6 [ PPA-AU-1499-PT-6] Safety of wind energy conversion systems (WBCS): Preliminary study [FFA-HU-2126] p0742 N80-28933 AEROSPACE CORP., EL SEGUEDO, CALIF. Study of hydrogen-powered versus battery-powered automobiles [ATR-79(7759)-1-VOL-1] p0665 N80-Byaluation of line focus solar central power p0665 N80-31271 systems. Volume 1: Executive summary [ATR-80(7773-03)-1-VOL-1] p0648 M80Evaluation of line focus solar central power systems. Volume 2: Systems evaluation [ATR-80(7773-03)-1-VOL-2] p0648 M80Residential photovoltaic systems: A review a comparative evaluation of four independent p0648 N80-31943 p0648 N80-31944 A review and studies of potential concepts
[SAND-80-7010] p0648 N80-31949
AIR FORCE ARRO PROPULSION LAB., WRIGHT-PATTERSON Military jet fuel from shale oil p0694 H80-29308
Ale Force Inst. Of Tech., Wright-Patterson Afb, Ohio.
A review of the methods for passive solar systems analysis [ AD-A087509 ] p0645 N80-31895 Comprehensive planning for passive solar architectural retrofit [AD-A088660]
AIR FORCE WRIGHT ARRONAUTICAL LABS.,
WRIGHT-PATTERSON APB, OHIO. p0659 N80-33907 A review of advanced vehicular diesel research and development programs which have potential application to stationary diesel power plants [AD-A085601] p0743 880-29738 Tests of a lightweight 200 kW MHD channel and diffuser p0751 N80-32226 [AD-A087022] Air Porce space power technology program p0782 N80-33468 AIR PRODUCTS AND CHEMICALS, INC., ALLERTONE, PA. Cryogenic methane separation/catalytic hydrogasification process analysis p0690 N80-28548 [ PE-3044-T6] A study of industrial hydrogen and syngas supply systems [ NASA-CB-163523] Cryogenic methane separation/catalytic hydrogasification process analysis [PB-3044-T7] p0704 N80-31635 ALABAMA UNIV. IN HUNTSVILLE. Solar energy for buildings handbook [ORO-5362-T1] p0631 N80-28880 ALASKA STATE DIV. OF EBERGY AND POWER DEVELOPMENT, ANCHORAGE. Minimizing consumption of exhaustible energy resources through community planning and design. Development of procedures for application during public facilities procurement process. Phase 2: Extension [ELC-2332-3] p0580 N80-29840
ALUNINUM CO. OF AMERICA, NEW REBSINGTON, PA.

Design and fabrication of a low cost Darrieus vertical axis wind turbine system, phase 1

[ALO-4272-T2]

p0578 880-28888

```
AMERICAE AIR FILTER CO., IEC., LOUISVILLE, EY.

Bruironmental air quality control from the
inside looking out
                                                                                         Pulse combustion technology for heating
                                                                                             applications
                                                                                             [ANL/EES/TH-85]
                                                                                                                                           p0707 N80-32467
                                                      p0592 N80-33960
                                                                                          Assessment of Peruvian biofuel resources and
AMERICAN SCIENCE AND ENGINEERING, INC., CAMBRIDGE,
                                                                                            alternatives
[ANL/EBS/TM-86]
                                                                                                                                           p0708 N80-32547
    Development of a second generation concentrating
                                                                                          Satellite Power Systems (SPS) cost review
                                                                                     [DOL/TIC-11190] p0654 N80
ARIZONA STATE UNIV., TEMPE.
Terrestrial photovoltaic power systems with sunlight concentration
[SAND-80-7008] p0648 N80
                                                                                                                                           p0654 N80-32928
       tracking solar collector [ASE-4524]
                                                      p0636 N80-29871
AMERICAN WIND EMERGY ASSOCIATION, WASHINGTON, D.C.
    Capital formation for small wind energy
                                                                                     [SAND-80-7008] p0648 #80-31942
ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND,
       conversion system manufacturers: A guide to
       methods and sources
       [SERI/TR-98298-1]
                                                      p0751 N80-32462
                                                                                     DOVER, H. J.
AMES LAB., IOWA.
Materials for coal liquefaction
[ISM-246] p0690 M80-285
Processes to increase utilization of power solid
                                                                                         Energy from wood waste - A case study
                                                                                                                                           p0670 A80-47594
                                                      p0690 N80-28549
                                                                                          Vapor cloud explosion studies in the United States
                                                                                                                                           p0590 N80-33595
       wastes
                                                                                     ARMY COLD REGIONS RESEARCH AND ENGINEERING LAB.,
                                                      p0702 N80-30929
       [ISH-245]
                                                                                     FORT WAINRIGHT, ALASKA.

The fate and effects of crude oil spilled on
    Photoelectrochemical solar cells based on d-band electrochemistry at transition metal diselenides
                                                                                            subarctic permafrost terrain in interior Alaska
       [IS-4724]
                                                      p0648 N80-31952
                                                                                             [ PB80-187305 ]
                                                                                                                                          p0585 880-31984
AHOCO OIL CO., MAPERVILLE, ILL.
Catalyst development for coal liquefaction
                                                                                     ARMY CONSTRUCTION ENGINEERING RESEARCH LAB.,
                                                                                     CHAMPAIGN, ILL.
Investigation of methods to predict thermal
                                                      p0696 N80-29508
       [EPRI-AF-1233]
APPLIED PHYSICS LAB., JOHES HOPKIES UBIV., LAUREL,
                                                                                            stratification and its effect on solar energy
                                                                                            system performance [AD-A086051]
                                                                                     (AD-A086051) p0636 H80-29864
ARHOLD ENGINEERING DEVELOPMENT CENTRE, ARHOLD AIR
    Report of the 6th Ocean Thermal Energy
       Conversion Conference. Ocean Thermal Energy
       for the 1980's
                                                                                     PORCE STATION, TENN.
                                                                                         HHD high performance demonstration experiment [FE-2895-7] p0751 N80-
       [COMP-790631-1]
                                                      n0701 N80-30922
                                                                                     [PR-2895-7] p0751 M80-32231
ASSOCIATED OCTEL CO. LTD., BLETCHLEY (ENGLAED).
    Low-cost flywheel demonstration program [DOB/ET-26931/T1] p077
                                                      p0778 N80-32897
    Low-cost flywheel demonstration program [COHS-5085-T2] p0780 H80-33909
                                                                                         Energy: Careful conservation or regulated waste
p0592 N80-33951
    Bnergy programs at the Johns Hopkins University
                                                                                     AUBURN UNIV., ALA.
       Applied Physics Laboratory
                                                                                         Seasonal thermal energy storage
[PB80-195316] p0783 N80-3391
APPLIED SOLAR BREEGY CORP., CITY OF INDUSTRY, CALIF.
Impact of terrestrial solar cell development on
                                                      D0783 N80-33919
                                                                                     [PNL-3322] PO
AUSTRIAB SOLAR AND SPACE AGENCY, VIRHNA.
                                                                                                                                           p0778 N80-32899
                                                                                         Regenerative energy sources for the production of low temperature heat: Energy sources,
       space applications
                                                      p0659 N80-33893
                                                                                            energy types, and energy conversion; results and applications; measures to promote use
ARATEX SERVICES, INC., ENCINO, CALIF.
                                                                                                                                          p0702 N80-30951
    Solar hot water demonstration project at Red
                                                                                            [ISBN-3-7041-0038-2]
                                                                                     AUTOMATION INDUSTRIES, INC., SILVER SPRING, MD.
Environmental data for sites in the Bational
Solar Data Network
       Star Industrial Laundry, Presno, California
Star Industrial Laguary, Fresho, [NASA-CE-161537]
ARCO SOLAR, INC., CHAISHORTH, CALIF.
Design and fabrication of combined photovoltaic-thermal collectors [SAHD-79-7008]
                                                      p0650 N80-32851
                                                                                         [SOLAR/0010-79/12] p0633 N80-28947 Energy/Environment 4: Proceedings of the
                                                                                             National Conference on the Interagency
                                                      p0652 N80-32890
ARGONEE BATIONAL LAB., ILL.

Heat-pump-centered integrated community energy systems: System development summary [ANL/CHSV-7] p0578 H80-2
                                                                                         Rhergy/Environment R and D Program
[PB80-177942] p0581 N80-
Environmental data for sites in the National
                                                                                                                                          p0581 N80-29928
                                                    P0578 N80-28885
                                                                                            Solar Data Network
    Preliminary comparative assessment of land use
for the Satellite Power System (SPS) and
alternative electric energy technologies
                                                                                             [SOLAR/0010-80/02]
                                                                                                                                           p0649 N80-31975
                                                                                     AVCO-EVERETT RESEARCH LAB., MASS.

Results from study of potential early commercial

MHD power plants and from recent ETF design work
                                                      P0580 N80-29886
       [NASA-CB-163327]
                                                                                                                                          p0717 A80-44107
    Selection of alternative central-station
       technologies for the Satellite Power System
                                                                                         Open-cycle MHD power conditioning and control requirements definition
        (SPS) comparative assessment
       [DOE/BR-0052]
                                                      p0580 N80-29887
                                                                                            [ BPRI-AP-1345]
                                                                                                                                           p0752 N80-32864
    Haterials technology for coal-conversion processes
[ABL-80-12] p0700 H80-30551
US Department of Energy's methane from landfills
                                                                                     Engineering test facility conceptual design [DOE/FE-2614/3] p0753 H8
AVCO SYSTEMS DIV., WILMINGTOB, MASS.
                                                                                                                                          p0753 #80-32943
       program
                                                                                         High energy density composite flywheel program [AD-A087076] p0777 #80-31892
        CONF-7910126-11
                                                      p0701 N80-30558
    Climate and energy: A comparative assessment of
       the Satellite Power System (SPS) and
       alternative energy technologies
       [ DOE/ER-0050 ]
                                                      p0581 N80-30914
                                                                                     BADGER PLANTS, INC., CAMBRIDGE, MASS.
Aspects of connercializing coal-derived methanol
    Comparative assessment of environmental welfare
       issues associated with the Satellite Power
System (SPS) and alternative technologies
                                                                                            fuels in the United States, 1985 to 2000.
                                                                                             Volume 1: Market evaluation
       [DOE/BR-0055]
                                                                                            [ PB-2416-44-VOL-1]
                                                      p0581 #80-30915
                                                                                                                                           p0690 N80-28542
    Comparative analysis of net energy balance for
                                                                                         Aspects of commercializing coal-derived methanol
       Satellite Power Systems (SPS) and other energy
                                                                                            fuels in the United States, 1985 to 2000.
       systems
                                                                                            Volume 2: Appendix [PE-2416-44-VOL-2]
       [DOE/ER-0056]
    [DOE/ER-0056] p0582 N80-30916
Development of advanced batteries at Argonne
                                                                                                                                          p0690 880-28543
                                                                                     BARBER-HICHOLS ENGINEERING CO., ARVADA, COLO.
Solar powered rankine cycle irrigation pump
[DOE/ET-20419/1] p0652 B80-32892
BARBES AND RELECCE, INC., ELK GROVE, ILL.
       National Laboratory
       [ANL-80-32]
                                                      p0776 H80-30927
    Hethodology for the comparative assessment of
the Satellite Power System (SPS) and
alternative technologies
[NASA-CE-163049] p0750 N80-
                                                                                         Steam engine analysis
                                                                                           [FB-8917-2]
                                                                                                                                          p0743 N80-29741
                                                      D0750 N80-31951
```

```
BATTELLE COLUMBUS LABS., OHIO.
     Carbohydrate crops as a renewable resource for fuels production. Volume 3: Juice preservation
     [BHI-2043] Thermophysical properties of coal liquids p0701 880-30557 Economic evaluation of the MIT process for
     manufacture of ethanol
[DSE-3992-T1] p0705 N80
Pilot study to select candidates for energy.
                                                                       p0705 N80-31607
     Conservation research for the chemical industry
[DOB/TIC-11114] p0584 N80-3194
Photovoltaic institutional issues study
                                                                      p0584 N80-31940
                                                                       p0584 N80-31950
        [SAND-79-7054]
     Design study of steel V-Belt CVT for electric
         vehicles
         [ NASA-CR-159845 ]
                                                                       p0777 N80-32299
BATTELLE INST., FRANKFURT AM MAIN (WEST GREMANY).
Development of a Cadmium selenide thin film
         solar cell
[BMFT-FB-T-79-72] p0640 N80-29907
BATTELLE NORTHEST LABS., EICHLAND, WASH.
     Seasonal thermal energy storage
         [PNL-3322]
[PNI-3322]
BATTELLE PACIFIC MORTHWEST LABS., RICHLAND, WASH.

Supplementary material on passive solar heating concepts: A compilation of published articles. Presented in conjunction with a series of passive solar heating seminars sponsored by the Solar Energy Technology Transfer program

[PNI-SA-7820] P0642 N80-30:

Siting handbook for small wind energy conversions.
                                                                       p0778 N80-32899
                                                                       p0642 N80-30920
      Siting handbook for small wind energy conversion
         systems
     [PNL-2521-REV-1] p0747 N80-30941 Workshop on Satellite Power Systems (SPS)
         Rffects on Optical and Radio Astronomy [CONF-7905143] p0643
     [CONF-7905143] p0643 M80-31435
Porous media experience applicable to field
evaluation for compressed air energy storage
[PNI-3294] p0777 N80-32873
Definition of gust model concept and review of
         qust models
                                                                       P0712 N80-33072
      Wind characteristics program element
[PNL-3211]
BDH CORP., MCLEAN, VA.
                                                                       p0754 N80-33073
      Photovoltaic applications definition and
         photovoltaic system definition study in the agricultural sector. Volume 2: Technical
         results
     [SAND-79-7018/2-VOL-2] p0586
Photovoltaic applications definition and
                                                                       p0586 N80-32870
         photovoltaic system definition study in the
         agricultural sector. Volume 3. Appendixes
[SAND-79-7018/3] p0652 N80-32891
BECHTEL INTERNATIONAL CORP., SAN PRANCISCO, CALIF.
Production of synthetic liquids from coal, 1980
- 2000. Preliminary study of potential
         impediments
[PE-3137-T1] p0696 H80-29510
BECHTEL HATIONAL, INC., SAB FRANCISCO, CALIF.
Combined cycle solar central receiver hybrid
power system study. Volume 1: Executive
         Summary
   [DOB/ET-21050/1-1] p0586 N80-
Combined cycle solar central receiver hybrid
power system study, volume 2
[DOB/ET-21050/1-2] p0586 N80-
                                                                      p0586 N80-32867
     Combined cycle solar central receiver hybrid
         power system study. Volume 3: Appendices [DOB/ET-21050/1-3-VOL-3] p0587 N80-
                                                                      p0587 N80-32893
BERGEN COUNTY UTILITIES AUTHORITY, LITTLE PERRY, H.J.
Peasibility study: Fuel cell cogeneration in a water pollution control facility, volume 1
[DOZ/ET-12431/T1-VOL-1] p0749 #80-31922
BIPHASE REERGY SISTERS, INC., SANTA BONICA, CALIF.
Design study of a two-phase turbine bottoming
         cycle
[DOE/ET-15350/T1] p0744 N8
BORING ARROSPACE CO., SEATTLE, WASH.
Solar thermophotovoltaic space power system
                                                                      p0614 A80-48208
     Emerging materials systems for solar cell
        applications: Cu/sub 2-x/Se [DOE/ET-23005/T3]
                                                                       p0632 N80-28895
```

```
BORIEG CO., SEATTLE, WASH.
 Solar project description for Sir Galahad
Company, single family residence, Virginia
Beach, Virginia
[SOLAR/1028-79/50] p0646 #80-31920
BOBING COMMENCIAL AIRPLANE CO., SEATTLE, WASH.
          Aviation fuels outlook
 BOOZ-ALLES AND HAMILTON, INC., BETHESDA, ND.
Alternative metering practices. Implications
for conservation in multifamily residences
               [ HCP/M1693-03]
[HCP/M1693-03]
BOSTON UNIV., MASS.
Organic photochemical storage of solar energy
[COO-4380-3] p0632 N80-28905
BRAUN (C. P.) AND CO., ALHAMBRA, CALIP.
Assessment of sulfur removal processes for advanced fuel cell systems
[EPRI-EM-1333] p0752 N80-32866
                                                                                                               p0579 N80-29838
 BRIGHAM YOUNG UNIV., PROVO, UTAH.
Alloy catalysts with monolith supports for methanation of coal-derived gases
                                                                                                               p0699 N80-30541
               [FE-2729-8]
         Investigation of sulfur-tolerant catalysts for
selective synthesis of hydrocarbon liquids
               from coal-derived gases
         [PE-14809-1] p0702 880-31502
Hixing and gasification of coal in entrained
flow systems. Volume 2: User's manual for a
computer program for 1-dimensional coal
 combustion or gasification (1-DICOG)
[PE-2666-P-VOL-2]
BRITISH LIBRARY LEBDING DIV., BOSTON SPA (REGLAND).
The pressurized fluidized bed gasification of
         The pressure of the property of the pressure of the property of the pressure o
 [BLL-RTS-12346]
BROOKHAVEN NATIONAL LAB., UPTON, N. Y.
         Alternative process schemes for coal conversion [BNL-51117] p0692 N80-28
                                                                                                               p0692 N80-28560
          Fuel cell applied research: Electrocatalysis
               and materials
               [BNL-51053]
          Ground coupled solar heat pump research program
          in the United States
[BNL-27383] pt
Photovoltaic/thermal hybrid projects
                                                                                                               D0636 N80-29867
               [BNL-27669]
                                                                                                               p0638 N80-29881
         Puel cell applied research: Electrocatalysis and materials
               [BNL-51072]
         Electric utilities and residential solar systems
[BNL-27711] p0638 N80-29888
Hybrid photovoltaic/thermal systems with a
         solar-assisted heat pump
[BNL-27667] p0642 N80-
Solar assisted heat pump program overview and
summary of work at Brookhaven National
                                                                                                               p0642 N80-30919
              Laboratory
[BNL-27662]
                                                                                                               p0642 N80-30926
          Comparative assessment of five long-run energy
               projections
[DOE/ELA/CE-0016/02]
         Fuel cells for electric utility and transportation acres
               transportation applications
               [BNL-27452]
                                                                                                               p0747 N80-30937
         [BBL-24925] Electrolysis-based hydrogen storage technology [BBL-26923] p0647 880-31928 Solar assisted heat pump studies: Heat pump
               hardware and experiments, simulations, Earth
               coupling contracts and supporting contracts
         COUPLING CONCLUSION
[BNL-27668] P0647 No.
Bydrogen production from remote power sites
[BNL-27457] P0666 No.
                                                                                                               p0647 N80-31933
                                                                                                               p0666 N80-32553
              electrolysis
[BNI-27782]
                                                                                                               p0667 N80-32559
         Advanced synfuels production/power systems utilizing laser particulate control [BHL-27783] p0710 H
                                                                                                              p0710 N80-32570
          Soot reduction in diesel engines by catalytic
               effects
              [BNL-27792]
          Bending behavior of lapped plastic BHV cables
         [BNL-27331] p0760 N80-32789
Reference energy systems as applied to regional
              energy policy
[BNL-26987]
                                                                                                               p0587 N80-32883
```

,	
Costing methodologies for energy systems	Material-flow data structures as a basis for
[BNL-27603] p0778 N80-32900	energy information system design
Simulation model for assessing building	[LBL-10248] p0760 #80-31923
energy-conservation policies	Evaluation of control strategies for solar
[BNL-27802] p0587 N80-32901	collector loops
Environmental control technology for carbon	[LBL-10716] p0647 N80-31932
dioxide	California's biomass and its energy potential
[DOE/EV-0079] p0588 N80-32972	[LBL-10058] p0709 N80-32564
Pusion: An energy source for synthetic fuels [BNL-27891] p0667 N80-33205	Seasonal thermal energy storage [PNL-3322] p0778 N80-32899
BROWN AND ROOT, INC., HOUSTON, TEX.	Spectral character of solar and circumsolar
Solar power satellite offshore rectenna study	radiation
[NASA-CR-161543] p0759 H80-30891	[LBL-10802] p0653 N80-32910
BROWN, BOVERI UND CIE, A.G., HEIDELBERG (WEST	Research on Cu sub x S/(cd, Zn)S photovoltaic
GERMANY).	solar energy converters
Development of sodium sulfur batteries	[LBL-10791] p0654 N80-3292
[BMPT-FB-T-79-60]. p0776 B80-29905	CALIFORNIA UNIV., DAVIS.
BUNDESHIMISTERION FURE PORSCHUNG UND TECHNOLOGIE,	Solar domestic hot water system, a comparative
BONE (WEST GERMANY).	study and storage tank investigation
Static investigation of rotor blades at rest and	p0643 N80-31860
under quasi-stationary loading	CALIFORNIA UNIV., LIVERMORE. LAWRENCE LIVERMORE LAB-
[ISD-243] p0747 N80-30948	Effect of a heated atmosphere on the emittance
Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on	of black chrome solar collector pipe surfaces [UCRL-83506] p0631 N80-2887
a rigid rotor blade with the leading-edge	Experimental studies of some regularities in the
angle of attack and flapping being coupled	underground gasification of inclined coal seams
[ISD-244] p0747 N80-30949	[UCRL-TRANS-11585] P0695 N80-29504
Dynamic analysis of a rotor blade with lead-lag	Reactively sputtered thin film cu/sub x/S/CdS
freedom, flapping freedom, and	photovoltaic devices
variable-controlled blade pitch angle	[UCID-18592] p0637 N80-29875
[ISD-258] p0747 N80-30950	Gasification of coal with solar energy
BURBAU OF COMMERCIAL PISHERIES, ANN ARBOR, MICH.	[UCRL-84458] p0643 N80-31652
Proceedings of the Clemson Workshop on	LLL in situ coal gasification project
Environmental Impacts of Pumped Storage	[UCRL-50026-79-4] p0705 N80-31654
Hydroelectric Operations [PB80-192453] p0588 H80-32964	Use of an automated mass spectrometer for an underground coal gasification field test
BURT, HILL, KOSAB, RITTLEHAH, AND ASSOCIATES,	[UCRL-84366] p0709 N80-32565
BUTLER, PA.	Economics of shale oil production by radio
Operation and maintenance cost data for	frequency heating
residential photovoltaic modules/panels	[UCRL-52942] p0710 N80-32566
[NASA-CR-163585] p0650 N80-32855	Comparative analysis of aluminum-air battery
	propulsion systems for passenger vehicles
C	[UCRL-52933] p0778 N80-32907
	Energy and technology review
CALIFORNIA BBERGY COMMISSION, SACRAMENTO.	[UCRL-52000-80-6] p0588 N80-32909
Environmental implications of electric utility	Solar gasification of charcoal, wood and paper [UCRL-84411] p0654 N80-32926
supply plans, 1978-2000 [PB80-192156]	[UCRL-84411] p0654 N80-32926 Analysis of aluminum-air battery propulsion
Methanol/ethanol/gasoline blend fuels	systems for passenger vehicles
demonstration with stratified charge engine	[UCRL-83824] p0778 N80-32940
vehicles	Aluminum air battery for electric vehicle
[PB80-192123] P0713 N80-33606	propulsion
Uranium resources: A review of estimation	[UCRL-84443] p0779 N80-3294
methodologies	Tandem mirror fusion-fission hybrid studies
[PB80-193725] p0714 N80-33920	[UCRL-84018] p0754 N80-33237
The potential of energy farming in the	CANTERBURY UNIV., CHRISTCHURCH (NEW ZEALAND).
southeastern California desert	The potential of energy farming for transport fuels in New Zealand
[PB80-195019] p0714 880-33921 CALIFORNIA UNIV., BERKELEY.	[PB80-154248] p0693 N80-28572
Solar energy conversion through biophotolysis	The potential of energy farming for transport
[SAB-0034-239-1-T2] p0666 N80-31927-	fuels in New Zealand, appendices
CALIFORNIA UNIV., BERKELEY. LANGENCE BERKELEY LAB.	[PB80-154255] p0693 N80-28573
The kinetics of the 02/CO2 reaction in molten	CARREGIE-BELLON UNIV., PITTSBURGH, PA.
carbonate - Reaction orders for 02 and CO2 on	Theoretical performance of multi-layer grid
NiO	patterns for solar cells
p0726 A80-48284	p0605 A80-46752
Biomass liquefaction efforts in the United States	Design of land-based, foam OTEC plants for
[LBL-10456] p0696 B80-29512 Human comfort and auxiliary control	bottoming cycles [CONF-790631-17] p0742 N80-28913
considerations in passive solar structures	CENTEC CORP., FORT LAUDERDALE, PLA.
[LBL-10034] p0640.N80-29903	The coating industry: Energy savings with
Overview-absorption/Rankine solar cooling program	volatile organic compound emission control
[LBL-10770] p0640 N80-29904	[TID-28706] p0579 N80-29833
Development of solar driven absorption air	CRETEO INFORMAZIONI STUDI ESPERIBUZE, MILAN (ITALY).
conditioners and heat pumps	Gallium arsenide solar cells for very high
[LBL-10771] p0642 N80-30925	concentration systems: Recent results,
Energy analysis program, FY 1979	problems and expectations
[LBL-10320] p0582 N80-30942	[CISE-1518] p0649 N80-31962
Metallurgical analysis and high temperature degradation of the black chrome selective	CHAMBERLAIN MPG. CO., WATERLOO, IOWA.  The 3X Compound Parabolic Concentrating (CPC)
absorber	solar energy collector
[LBL-10293] p0643 N80-31538	COARE CHERAL CATTERINE
Bultiphase reactor modeling for zinc chloride	[DOB/CS-04239/T1] D0655 N80-32944
	[DOB/CS-04239/T1] p0655 N80-32944 CHEMICAL ENGINEERING RESEARCH GROUP, PRETORIA
catalyzed coal liquefaction	
catalyzed coal liquefaction [LBL-9870] p0703 N80-31628	CHEMICAL ENGINEERING RESEARCH GROUP, PRETORIA
catalyzed coal liquefaction [LBL-9870] p0703 N80-31628 Liquid fuels from biomass: Catalysts and	CHEMICAL ENGINEERING RESEARCH GROUP, PERTORIA (SOUTH AFRICA). Preparation and stability of enulsions of methanol in automobile diesel oil
catalyzed coal liquefaction [LBL-9870] p0703 N80-31628	CHEMICAL ENGINEERING RESEARCH GROUP, PRETORIA (SOUTH AFRICA).  Preparation and stability of enulsions of

DEPARTMENT OF ENERGY, CORPORATE SOURCE INDEX

CHER SYSTEMS RESEARCH CENTER, FAIRFIELD, B.J.	
	COMMITTEE OF INTERSTATE AND PORRIGH COMMERCE (U.
Development of alcohol-based synthetic	S. HOUSE).
transportation fuels from coal-derived	Energy policy: Supply and demand alternatives
synthesis gases [DOB/ET-14858/T1] p0692 N80-28566	[GPO-56-541] p0591 M80-33870 Incentives for energy conservation
Liquid-phase methanol	[GPO-55-634] p0591 N80-33871
[EPRI-AF-1291] p0692 N80-28567	COMMITTER ON SCIENCE AND TECHNOLOGY (U. S. HOUSE).  DOE authorization, 1981, volume 2
CHEVRON RESEARCH CO., BICHMOND, CALIF. Refining and upgrading of synfuels from coal and	[GPO-61-774-VOL-2] p0581 880-30224
oil shales by advanced catalytic processes	NASA authorization, 1981, volume 5
[FE-2315-40] p0691 N80-28550 Refining and upgrading of synfuels from coal and	[GPO-61-213-VOL-5] p0581 H80-30225 Oversight: Alternate liquid fuels technology
oil shales by advanced catalytic processes.	[GPO-50-313] p0590 N80-33580
Laboratory and pilot plant studies of the	Oversight: Cost estimation techniques for
processing of SBC-1 [PB-2315-45] p0699 N80-30544	emerging synthetic fuels technology, volume 9 [GPO-51-721] p0590 N80-33581
Refining and upgrading of synfuels from coal and	Oversight: Wind energy program
oil shales by advanced catalytic processes	[GPO-51-382] p0591 880-33872
[FE-2315-48] p0703 N80-31629 CHICAGO UNIV., ILL.	COOPERSON BRACK ASSOCIATES, MONTCHANIN, DEL. Solar energy system demonstration project at
Reduction of intensity variations on the	Wilmington Swim School, New Castle, Delaware
absorbers of ideal flux concentrators p0598 A80-46452	[NASA-CR-161538] p0644 N80-31878 COPPIE STATE COLL., BALTIMORE, HD.
Fundamentals and techniques of nonimaging optics	An accelerated test design for use with
for solar energy concentration	synchronous orbit
[DOE/ER-04657/2] p0652 N80-32896 CHRYSLER CORP., DETROIT, MICH.	p0770 A80-48401 COURCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.
Upgraded automotive gas turbine engine design	PRETORIA (SOUTH APRICA).
and development program, volume 2	Preparation and stability of emulsions of
[NASA-CE-159671] p0751 N80-32719 CITIZENS MUTUAL SAVINGS AND LOAN ASSOCIATION,	methanol in automotive diesel oil [PB80-169162] p0697 N80-29526
LEAVESCORTE, KABS.	International Conference on Air Pollution,
Solar heating and cooling system installed at	volume 1
Leavenworth, Kansas [NASA-CR-161484] p0635 N80-29848	[ISBN-0-7988-16651] p0592 N80-33929 International Conference on Air Pollution,
CITY COUNCIL OF CAPE TOWN (SOUTH AFRICA).	volume 3
Municipal refuse as a fuel for power generation	[ISBN-0-7988-1665-1] p0592 N80-33943
CITY OF KANSAS CITY, NO.	International Conference on Air pollution, volume 4
Solar heating and domestic hot water system	p0592 N80-33954
installed at Kansas City, Fire Stations,	Environment: The energy connection
Kansas City, Missouri [NASA-CR-161513] p0641 N80-30895	p0592 H80-33955 COUNCIL ON ENVIRONMENTAL QUALITY, WASHINGTON, D.C.
CITY OF PORT ELIZABETH (SOUTH AFRICA).	The global 2000 report to the president.
Otilization of municipal refuse as an energy	Entering the twenty-first century. Volume 2:
source p0714 N80-33952	The technical report p0782 N80-32296
COLORADO SCHOOL OF MINES, GOLDEN.	CRISTAL SISTEMS, INC., SALEM, MASS.
Mechanisms of nitrogen heterocycle influence on turbine fuel stability	Low-cost, high-efficiency silicon by heat exchanger method and fixed abrasive slicing
p0695 N80-29327	technique
Experimental design for Hydraulic Transport	p0600 A80-46700
Da Da 11 1 4	
Research Facility [FE-3274-1] D0759 N80-29629	D
[FE-3274-1] p0759 N80-29629 COLORADO STATE UHIV., FORT COLLIES.	D
[PE-3274-1] p0759 N80-29629 COLOBADO STATE UHIV., FORT COLLINS. Cost-effective ways to improve the fabrication	DALLAS INDEPENDENT SCHOOL DISTRICT, TEX.
[FE-3274-1] p0759 N80-29629 COLORADO STATE UNIV., FORT COLLINS. Cost-effective ways to improve the fabrication and installation of solar heating and cooling	Solar heating and domestic hot water system
[PE-3274-1] p0759 N80-29629  COLORADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [COO-4520-1] p0632 N80-28902	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847
[FE-3274-1] COLOBADO STATE UNIV., FORT COLLINS. Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [COO-4520-1] Sites for wind-power installations: Physical	Solar heating and domestic hot water system installed at Worth Dallas High School [NASA-CE-161482] p0634 N80-29847 DARTHOUTH COLL., HANOVER, N.H.
[PE-3274-1] p0759 N80-29629  COLORADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO0-4520-1] p0632 N80-28902  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847
[FE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO-4520-1]  p0632 N80-28902  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847 DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [PB80-185002] p0584 N80-31968
[PE-3274-1] p0759 N80-29629  COLORADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [COO-4520-1] p0632 N80-28902  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [RLO-2438-78/1] p0706 N80-31900	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CE-161482] p0634 N80-29847 DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [PB80-185002] p0584 N80-31968 DELAWARE UNIV., NEWARK.
[FE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [COO-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [BLO-2438-78/1]  Sites for wind-power installations: Wind	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [PB80-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for
[PE-3274-1]  COLORADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [COO-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [RLO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RLO-2438-78/2]  PO706 N80-31901	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H.  Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., HEWARK.  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [COO-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RLO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RLO-2438-78/2]  Residential solar heating and cooling using	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [PB80-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482 Development of unique catalysts for
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO0-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H.  Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., HEWARK.  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [COO-4520-1]  P0632 N80-28902  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RLO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RLO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [COO-2858-24]  P0647 N80-31941	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for
[PE-3274-1]  COLDBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [COO-2656-24]  COMBUSTION ENGINEERING, INC., WINDSOR, CONN.	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [PB80-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [COO-4520-1]  P0632 N80-28902  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RLO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RLO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [COO-2858-24]  P0647 N80-31941	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO0-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [COO-2656-24]  COMBUSTION ENGIBERERING, INC., WINDSOR, CONN.  Results from study of potential early commercial MHD power plants and from recent ETF design work p0717 A80-944107	Solar beating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [PB80-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK.  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-3] p0690 N80-28546  DEPARTHENT OF REREGY, BARTLESVILLE, OKLA, Aviation turbine fuels, 1979
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO-4520-1]  P0632 N80-28902  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [COO-2658-24]  COMBUSTION ENGINERRING, INC., WINDSOR, CONN.  Results from study of potential early commercial MHD power plants and from recent ETT design work p07171 A80-44107  COMMISSION OF THE EUROPEAN COMMUNITIES, ISPRA	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., HEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-3] p0690 N80-28545  DEPARTMENT OF ENERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PFS-80/2] p0703 N80-31627
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO0-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [CO0-2656-24]  COMBUSTION ENGINEERING, INC., WINDSOR, CONN.  Results from study of potential early commercial MHD power plants and from recent ETF design work p0717 A80-44107  COMMISSION OF THE EUROPEAN COMMUNITIES, ISPRA (ITALI).  Standard procedures for terrestrial photovoltaic	Solar beating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [PB80-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK.  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-3] p0690 N80-28545  DEPARTMENT OF EMERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PFS-80/2] p0703 N80-31627  DEPARTMENT OF ENERGY, GRAND FORKS, N. DAK. Effect of operating conditions on production of
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [COO-2658-24]  COMBUSTION ENGINERRING, INC., WINDSOR, CONN.  Results from study of potential early commercial MHD power plants and from recent ETF design work p07171 A80-44107  COMMISSION OF THE EUROPEAN COMMUNITIES, ISPRA (ITALY).  Standard procedures for terrestrial photovoltaic performance measurements: Specification no. 101	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK.  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-3] p0690 N80-28546  DEPARTHENT OF ENERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  DEPARTHENT OF ENERGY, GRAND FORKS, N. DAK. Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO0-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [CO0-2656-24]  COMBUSTION ENGINEERING, INC., WINDSOR, CONN.  Results from study of potential early commercial MHD power plants and from recent ETF design work p0717 A80-44107  COMMISSION OF THE EUROPEAN COMMUNITIES, ISPRA (ITALI).  Standard procedures for terrestrial photovoltaic	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANGVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-3] p0690 N80-28545  DEPARTMENT OF ENERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  DEPARTMENT OF ENERGY, GRAND FORKS, N. DAK. Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed coal gasification
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO-4520-1]  P0632 N80-28902  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [COO-2658-24]  COMBUSTION ENGINERRING, INC., WINDSOR, CON.  Results from study of potential early commercial MHD power plants and from recent ETF design work p0717 A80-44107  COMMISSION OF THE EUROPEAN COMMUNITIES, ISPRA (ITALY).  Standard procedures for terrestrial photovoltaic performance measurements: Specification no. 101 [ZUR-6423EN]  COMMITTER OF COMPERENCE (U. S. COMGRESS).  National Aeronautics and Space Administration	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-3] p0690 N80-28546  DEPARTHENT OF ENERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  DEPARTHENT OF ENERGY, GRAND FORKS, N. DAK. Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed coal gasification [GPETC-FR-80/2] p0695 N80-29507  DEPARTHENT OF ENERGY, PITTSDURGE, PA.
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO0-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RLO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RLO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [CO0-2858-24]  COMBUSTION ENGINERRING, INC., WINDSOR, CONN.  Results from study of potential early commercial MED power plants and from recent ETF design work p0717 A80-44107  COMMISSION OF THE EUROPPANE COMMUNITIES, ISPRA [TALY].  Standard procedures for terrestrial photovoltaic performance measurements: Specification no. 101 [RUR-64238N]  P0637 N80-29877  COMMITTEE OF COMPERBRECE (U. S. COMGERSS).  National Aeropautics and Space Administration Authorization Act, 1981	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANGVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-3] p0690 N80-28545  DEPARTMENT OF ENERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  DEPARTMENT OF ENERGY, GRAND FORKS, N. DAK. Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed coal gasification [GFETC/RI-80/2] p0695 N80-29507  DEPARTMENT OF ENERGY, PITTSBUEGE, PA. Recent coal-oil mixture combustion tests at PETC
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO-4520-1]  P0632 N80-28902  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [COO-2658-24]  COMBUSTION ENGINERRING, INC., WINDSOR, CON.  Results from study of potential early commercial MHD power plants and from recent ETF design work p0717 A80-44107  COMMISSION OF THE EUROPEAN COMMUNITIES, ISPRA (ITALY).  Standard procedures for terrestrial photovoltaic performance measurements: Specification no. 101 [ZUR-6423EN]  COMMITTER OF COMPERENCE (U. S. COMGRESS).  National Aeronautics and Space Administration	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-3] p0690 N80-28546  DEPARTHENT OF ENERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  DEPARTHENT OF ENERGY, GRAND FORKS, N. DAK. Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed coal gasification [GPETC-FR-80/2] p0695 N80-29507  DEPARTHENT OF ENERGY, PITTSDURGE, PA.
[PE-3274-1]  COLDRADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO0-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RLO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RLO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [CO0-2858-24]  COMBUSTION ENGINERBING, INC., WINDSOR, CONN.  Results from study of potential early commercial MED power plants and from recent ETF design work p0717 A80-44107  COMMISSION OF THE EUROPPAN COMMUNITIES, ISPRA  (ITALY).  Standard procedures for terrestrial photovoltaic performance measurements: Specification no. 101 [RUR-6423EN]  POSST NEO-29877  COMMITTER OF COMPERBECE (U. S. COMGRESS).  National Aeronautics and Space Administration Authorization Act, 1981 [PUB-LAN-96-316]  COMMITTER OF COMPERER, SCIENCE, AND TRANSPORTATION  (U. S. SENATE).	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANGVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-3] p0690 N80-28545  DEPARTMENT OF ENERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  DEPARTMENT OF ENERGY, GRAND FORKS, R. DAK. Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed coal gasification [GPETC/RI-80/2] p0695 N80-29507  DEPARTMENT OF ENERGY, PITTSBURGH, PA. Recent coal-oil mixture combustion tests at PETC [DOE/FETC-TR-80/5] DEPARTMENT OF ENERGY, HASHINGTON, D. C. Alternative fuels, fuel additives and related
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO-4520-1]  P0632 N80-28902  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence. Part 1: Executive summary [RIO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RIO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [COO-2656-24]  COMBUSTION ENGIRERRING, INC., WINDSOR, CONN. Results from study of potential early commercial MHD power plants and from recent ETF design work p0717 A80-44107  COMMISSION OF THE BUROPEAN COMMUNITIES, ISPRA (ITALY).  Standard procedures for terrestrial photovoltaic performance measurements: Specification no. 101 [RUR-6423EN]  COMMITTEE OF COMPERENCE (U. S. CONGERSS).  National Aeronautics and Space Administration Authorization Act, 1981 [PUB-LAM-96-316]  P0581 N80-30226  COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION	Solar heating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANOVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [P880-185002] p0584 N80-31968  DELAWARE UNIV., NEWABK.  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [FE-3297-3] p0690 N80-28546  DEPARTHENT OF ENERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PPS-80/2] p0703 N80-31627  DEPARTHENT OF ENERGY, GRAND FORKS, N. DAK. Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed coal gasification [GPETC/RI-80/2] p0695 N80-29507  DEPARTHENT OF ENERGY, PITTSBURGE, PA. Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TR-80/5] p0706 N80-31658  DEPARTHENT OF ENERGY, WASHINGTON, D. C.
[PE-3274-1]  COLOBADO STATE UNIV., FORT COLLINS.  Cost-effective ways to improve the fabrication and installation of solar heating and cooling systems for residences [CO0-4520-1]  Sites for wind-power installations: Physical modeling of the influence of hills, ridges and complex terrain on wind speed and turbulence.  Part 1: Executive summary [RLO-2438-78/1]  Sites for wind-power installations: Wind characteristics over ridges, part 2 [RLO-2438-78/2]  Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House 3, executive summary [CO0-2258-24]  COMBUSTION ENGINEERING, INC., WINDSOR, COHN.  Results from study of potential early commercial NHD power plants and from recent ETF design work p0717 A80-44107  COMMISSION OF THE EUROPEAN COMMUNITIES, ISPRA (ITALI).  Standard procedures for terrestrial photovoltaic performance measurements: Specification no. 101 [EUR-6423EN]  COMMITTEE OF COMPERBECE (U. S. CONGRESS).  National Aeronautics and Space Administration Authorization Act, 1981 [PUB-LAN-96-316]  COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION (U. S. SEMATE).  Laser technology: Development and applications	Solar beating and domestic hot water system installed at North Dallas High School [NASA-CR-161482] p0634 N80-29847  DARTHOUTH COLL., HANGVER, N.H. Interactions between energy supply and transportation-related energy use, volume 1 [PB80-185002] p0584 N80-31968  DELAWARE UNIV., NEWARK. Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-1] p0690 N80-28482  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-2] p0690 N80-28545  Development of unique catalysts for hydrodenitrogenation of coal-derived liquids [PE-3297-3] p0690 N80-28545  DEPARTHENT OF ENERGY, BARTLESVILLE, OKLA. Aviation turbine fuels, 1979 [DOE/BETC-PFS-80/2] p0703 N80-31627  DEPARTHENT OF ENERGY, GRAND FORKS, H. DAK. Effect of operating conditions on production of light hydrocarbon gases in slagging fixed-bed coal gasification [GPETC/RI-80/2] p0695 N80-29507  DEPARTHENT OF ENERGY, PITTSBURGH, PA. Recent coal-oil mixture combustion tests at PETC [DOE/PETC-TR-80/5] p0706 N80-31658  DEPARTHENT OF ENERGY, WASHINGTON, D. C. Alternative fuels, fuel additives and related devices for highway vehicles: B, D and D

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Environmental data energy technology characterizations: Coal
                                                                                                                     DORNIER-BERKE G.M.B.H., PRIEDRICHSHAPEN (WEST
                                                                                                                     GERMANY).
            [ DOB/EV-0074 ]
                                                                          p0577 N80-28882
                                                                                                                          Development of high temperature resistant, solar
       International energy indicators
[DOE/IA-00017/3(80)] p078
Outlook for alternative energy sources
                                                                                                                              absorber surfaces
[BMFT-FB-T-79-70]
                                                                           p0781 N80-28919
                                                                                                                                                                                             p0640 N80-29906
                                                                                                                    Study on the utilization of solar energy for the operation of Spacelab material science furnaces [DS-ERT-21-79] p0640 M80-30349

DOW CORMING CORP., HEMLOCK, MICH.

Progress on the Dow Corning process for solar-grade silicon
                                                                          p0694 N80-29302
       Characteristics of the housing stock and
households: Preliminary findings from the
Hational Interim Energy Consumption Survey
                                                                                                                                                                                             p0640 N80-30349
                                                                          p0579 #80-29839
       Satellite Power System (SPS) PY 79 program summary
                                                                                                                                                                                             D0600 A80-46699
       [NASA-CR-163479] poor Environmental data, energy technology characterizations: Geothermal
                                                                           P0639 N80-29900
                                                                                                                     DRAVO CORP., PITTSBURGE, PA.
                                                                                                                          Pittsburgh Energy Technology Center
hydrogasification process: Conceptual
commercial scale plant design
           [ DOB/BV-0077 ]
                                                                           p0580 M80-29912
       Solar energy system performance evaluation report for IBM System 4 at Clinton, Mississippi [MASA-CR-161509] p0641 N80-30893
                                                                                                                              [ DOE/MC-08484/T1]
                                                                                                                                                                                             p0703 N80-31633
                                                                                                                    DREXEL USIV., PHILADELPHIA, PA.

Industrial application and assessment of waste energy recovery technologies
       Solar energy system economic evaluation final
report for SBECO-Loxahatchee, Loxahatchee
Bational Wildlife refuge, Palm Beach County,
                                                                                                                                                                                             p0745 N80-30886
                                                                                                                     DIWATECE CORP., CAMBRIDGE, MASS.
Liquid fuels production from biomass
[COO-4388-10] pt
           Plorida
      p0641 H80-30894
Solar energy system performance evaluation
report for IBM System 3, Glendo, Wyoming
[MASA-CB-161520] p0641 H80-30806
                                                                                                                                                                                            p0708 N80-32545
       Report of the 6th Ocean Thermal Energy
Conversion Conference. Ocean Thermal Energy
for the 1980's
                                                                                                                    BAGLE-PICHER INDUSTRIES, IHC., JOPLIE, MO.
Nickel-zinc batteries for RPV applications
[AD-a088594] p0780 N
                                                                                                                                                                                            p0780 N80-33908
                                                                                                                    RATCH CORP., SOUTHFIELD, MICH.

Small passenger car transmission test; Chevrolet
LUV transmission
[NASA-CE-159882] p0584 M80-3179

ECOM, INC., PRINCETOM, H. J.
           [CONF-790631-1]
                                                                          P0701 N80-30922
       Assessment of the US Mirror Pusion program.
Report of the 1980 Mirror Senior Review Panel
           [ DOE/BR-0057 ]
                                                                          p0748 880-31214
                                                                                                                                                                                             D0584 N80-31796
       Coean energy systems: Multiyear program plan
[p08/CS-0161] p0707 M80-31946
Pirst report to Congress on the use of alcohol
in Motor fuels
[p08/CS-0165] p0708 M80-32548
                                                                                                                    SPS salvage and disposal alternatives
[NASA-CR-161548] p0641 N80-3

EDDB (HOWARD), INC., BELLEVUE, WASH.

Energy conservation and environmental benefits
                                                                                                                                                                                            p0641 N80-30898
       Coal demonstration plants . [DOE/FE-0004/79-2]
                                                                                                                              of thermal energy storage systems in the pulp
                                                                          p0709 N80-32555
                                                                                                                              and paper industry
       International energy indicators [DOB/IA-0010]
                                                                                                                                                                                            p0763 A80-48194
                                                                                                                    EDGERTON, GERMESHAUSEN AND GRIER, INC.,
ALBUQUERQUE, B. HEX.
Concentrating solar collector test results
[SAND-80-0801C] p0633 N
                                                                          p0588 N80-32918
       Environmental assessment. Energy efficiency standards for consumer products [DOE/CS-0168] p0589 B80-
                                                                          p0589 N80-32988
                                                                                                                                                                                            p0633 N80-28912
      Environmental-control-technology activities of
the Department of Energy in PY 1979
                                                                                                                    EDGERTOR, GERMESHAUSEN AND GRIER, INC., IDAHO
                                                                                                                    PALLS, IDAHO.
Heat pumps in low temperature applications
           [ DOE/EV-0084 ]
                                                                          p0589 N80-32989
      Cogeneration Technology Alternatives Study (CTAS). Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler,
                                                                                                                             [CONF-800806-7]
                                                                                                                                                                                            p0711 N80-32699
                                                                                                                    BHRENKRANTZ GROUP, NEW YORK, H. Y.
                                                                                                                    Active solar energy system design practice manual [SOLAE/0802-79/01] p0632 N80-28889 RIC, INC., REWTON, MASS.
Hydrogen production by photoelectrolytic decomposition of H2O using solar energy [NASA-CH-163586] p0667 N80-32854
COAL-TIFE A DECOGENERATION PROCESS BOILER,
SECTION A
[MASA-CR-159770-PT-1] P0591 N80-33860
DEPARTMENT OF SHERGY (US), LONDON (ENGLAND).
Working group on fuel consumption targets
[NF-24333]
DEPARTMENT OF MATIONAL DEPENCE, OTTAWA (ONTARIO).
Evaluation of Cranking characteristics of
commercially available batteries between room
temperature and -40 C
                                                                                                                    ELCAH, INC., SANTA BARBABA, CALIF.
Installation package for a sunspot cascade solar water heating system
[NASA-CR-161562] p0657 N80-3386
           temperature and -40 C
 [AD-A080614] p0780 B80-33906 DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH,
                                                                                                                    Design package for solar domestic hot water system
[NASA-CR-161558] p0657 N80-33867
RLECTRIC POWER RESEARCH IEST., PALO ALTO, CALIF.
 CHRISTCHURCH (NEW ZEALAND).

The potential of energy farming for transport fuels in New Zealand
[PB80-154248] p0693 N80-:
                                                                                                                          Electric utility solar energy activities:
                                                                                                                             1979survey
[EPRI-ER-1299-SR]
                                                                                                                                                                                            p0631 N80-28879
      The potential of energy farming for transport fuels in New Zealand, appendices
[PB80-159255]
                                                                                                                          Manual and programmable calculator methods for
                                                                                                                             sizing solar energy systems [EPRI-BR-1282-SR]
                                                                         p0693 #80-28573
                                                                                                                                                                                            p0632 N80-28890
                                                                                                                          Energy economic projections for the 1979 overview [EPRI-PS-79-5-LD] p0578 M80-28918
 DEUTSCHE AUTOMOBILGESELLSCHAPT H.B.H., ESSLIEGEN
 (WEST GREMANY) .
      Bickel hydrogen cell development centered on
positive electrodes with high capacity per
                                                                                                                    BLECTRICITY COMMISSION OF NEW SOUTH MALES, SYDNEY
                                                                                                                    (AUSTRALIA).
           unit area for load leveling and traction
                                                                                                                         Collecting fly ash from low sulphur coals: An Overview of Australian experience
           applications
[BHFT-FB-T-79-74] PO776 H80-29
DROTSCHE VERSUCHSANSTALT FUER LUFT- UED RAUMFAHRT,
                                                                         p0776 N80-29908
                                                                                                                                                                                            p0592 N80-33932
                                                                                                                    ENCOTECE, INC., SCHENECTADY, N.Y.
Worldwide survey of current experience burning
DEUTSCHE VERSUCHSABSTALT FUER LUFF- UND HAUFFAHRY,
BAD GODESBERG (FEST GERHANY).

The use of computer-controlled manipulators in
underwater technology
[DFVLE-HITT-78-02] p0714 H80-3

DIAMOND SHAMROCK CHEMICAL CO., CLEVELAND, OHIO.
Oxygen electrodes for energy conversion and
                                                                                                                             residual and crude oils in gas turbines
                                                                                                                    [EPRI-AF-1243] P0693 N80-28724
ENERGY AND ENVIRONMENTAL ANALYSIS, INC., ARLINGTON,
                                                                                                                         Technical and economic feasibility of alternative fuel use in process heaters and
          [DOE/ET-25502/1]
                                                                         P0753 B80-32878
                                                                                                                             small boilers
                                                                                                                             [DOE/BIA-10547/01]
                                                                                                                                                                                            p0693 N80-28570
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ENERGY DEVELOPMENT ASSOCIATES, MADISON HEIGHTS, MICH.	FUG ASSOCIATES, IEC., TULLAHOMA, TENH.
Development of the zinc-chloride battery for	Summary of guidelines for siting wind turbine
utility applications	generators relative to small-scale,
[EPRI-BH-1417] p0778 N80-32917	two-dimensional terrain features
ENERGY ENGINEERING, INC., ALBUQUERQUE, N. MEX. Analysis of a passive heat pipe cooled solar	[RLO-2443-77/1] p0647 N80-31930
. photovoltaic receiver	${f G}$ .
[SAND-80-7011] p0651 N80-32885	
ENERGY RESEARCH CORP., DANBURY, CONN.	GENERAL ACCOUNTING OFFICE, WASHINGTON, D. C.
Aqueous trifluoromethanesulfonic acid fuel cells [AD-A086579] p0745 M80-30905	The 20 percent solar energy goal: Is there a plan to attain it?
RHERGY RESOURCES CO., INC., CAMBRIDGE, MASS.	[END-80-64] p0638 N80-29880
Feasibility of alternatives for surface	Federal demonstrations of solar heating and
utilization of coal wastes	cooling on commercial buildings have not been
[PE-3105-1] p0692 N80-28563 BHGINEBRING SOCIETIES COMMISSION ON ENERGY, INC.,	very effective [BND-80-41] p0750 N80-31929
WASHINGTON, D. C.	GREERAL ATOMIC CO., SAN DIEGO, CALIP.
Survey of world coal energy studies and	Solaroil project. Phase 1: Preliminary design
international coal mining research	report
[FE-2468-68] p0691 N80-28551 Materials for coal conversion and use. Volume	[GA-A-15823] p0633 N80-29505 Hydrogen production by the GA sulfur-iodine
2: Materials of construction for coal	process
conversion systems. Part 1: Coal	[GA-A-15777-REV] p0666 N80-31651
gasification. Part 2: Coal liquefaction	Conceptual design of RST: An rf-driven,
[FE-2468-59-VOL-2-PT-1/2] p0705 N80-31644	steady-state Tokamak [BPRI-AP-1351] p0751 N80-32233
ENVIRONMENTAL PROTECTION AGENCY, ANN ARBOR, MICH.  Evaluation of the Ram-Jet device, a PCV air bleed	GENERAL DYNAMICS/CONVAIR, SAN DIEGO, CALIP.
[PB80-170657] p0582 N80-30964	Power management for multi-100 KWe space systems
Effects of gasohol on idle HC and CO emissions	p0758 A80-48357
[PB80-190655] p0590 H80-33018	Study of power management technology for orbital
ESCHEE TECHNOLOGY ASSOCIATES, ST. JOHNS, MICE. Assessment of hydrogen compressor technology for	multi-100KWe applications. Volume 3: Requirements
energy storage and transmission systems	[NASA-CR-159834] p0759 N80-29845
[ORO-5598-T1] p0667 N80-32922	GENERAL ELECTRIC CO., PAIRPIELD, CONN.
EUROPEAN SPACE AGENCY, PARIS (PRANCE).	Cogeneration Technology Alternatives Study
Photovoltaic generators in space [RSA-SP-147] p0658 N80-33873	(CTAS). Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler,
EUROPEAN SPACE RESEARCH AND TECHNOLOGY CENTER,	section A
NOORDWIJK (NETHERLANDS).	[ NASA-CR-159770-PT-1-A ] p0745 N80-30888
European technology applicable to Solar Power	Cogeneration Technology Alternatives Study
Satellite Systems (SPS) [INKA-CONP-79-378-046] p0637 N80-29878	(CTAS). Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler,
EUROPEAN SPACE TECHNOLOGY CENTER, MOORDWIJK	section B
(HETHERLANDS).	[NASA-CH-159770-PT-1-B] p0745 N80-30889
Efficient thermal cycling of solar panels in	Cogeneration Technology Alternatives Study (CTAS). Volume 6: Computer data. Part 2:
solar simulation facilities with a multi-panel test rig	Residual-fired nocogeneration process boiler
p0659 N80-33898	[NASA-CR-159770-PT-2] p0745 N80-30890
Satellite power systems: Status and planned	GENERAL RLECTRIC CO., PHILADELPHIA, PA.
activities p0760 N80-33904	Parametric study of prospective early commercial OCHHD power plants /PSPEC/
REMON RESEARCH AND ENGINEERING CO., LINDEN, N.J.	p0717 A80-44106
Effect of refining variables on the properties	Design of a photovoltaic system for a southwest
and composition of JP-5	all-electric residence [SAND-79-7056] p0637 N80-29876
p0694 N80-29306 Hiniplant and bench studies of pressurized	Design and development of Stirling engines for
fluidized-bed coal combustion	stationary power applications in the 500 to
[PB80-188121] p0712 N80-32999	3000 hp range. Subtask 1A report:
E	State-of-the-art conceptual design [DOB/ET-15209/T1] p0744 H80-30755
•	Cogeneration Technology Alternatives Study
PILTROL CORP., LOS ANGELES, CALIP.	(CTAS). Volume 3: Industrial processes
Development of new catalysts for coal liquids	[NASA-CR-159767] p0749 N80-31870 GENERAL ELECTRIC CO., SCHEHECTADY, H. Y.
refining [FE-2595] p0691 N80-28553	Development of high-temperature turbine
Development of new catalysts for coal liquid	subsystem technology to a technology readiness
refining	status, phase 2
[FE-2595-5] PO710 N80-32569 PIRST NATIONAL BANK OF CLARKSDALE, MISS.	[PE-1806-67] p0693 N80-28726 Regenerative flywheel energy storage system
Solar heating system at Quitman County Bank,	[UCRL-13982-REV-1] p0775 N80-28884
Marks, Mississippi	Development of high-temperature turbine
[NASA-CR-161549] p0657 N80-33858	subsystem technology to a technology readiness
PLORIDA UNIV., GAINESVILLE.  Effects of thermal annealing on the deep-level	status, phase 2 [PE-1806-86] p0701 M80-30753
defects and I-V characteristics of 200 keV	High-temperature turbine technology program.
proten irradiated AlGaAs-GaAs solar cells	Overall Plant Design Description (OPDD)
p0613 A80-48204	coal-derived liquid
Oxidation of electrodeposited black chrome selective solar absorber films	[PE-1806-84] p0712 B80-32728 High-temperature turbine technology program.
[SAND-80-1045C] p0656 N80-32953	Overall Plant Design Description (OPDD)
FORD MOTOR CO., DEARBORN, MICH.	low-Btu coal gas electric power plant
Status of the Ford program to evaluate ceramics	[PE-1806-83] p0752 B80-32729
for stator applications in automotive gas turbine engines	Cogeneration Technology Alternatives Study (CTAS). Volume 4: Energy conversion systems
·p0720 A80-45375	[NASA-CR-159768] p0755 N80-33859
PRANKLIN RESEARCH CRNTER, PHILADELPHIA, PA.	
Self controlling, self pumping heat circulation system study	
[COO-4484-07] p0656 N80-32952	

```
Cogeneration Technology Alternatives Study (CTAS). Volume 6: Computer data. Part 1: Coal-fired nocogeneration process boiler,
            section A
       [BASA-CR-159770-PI-1] p0591 880-33860
Cogeneration Technology Alternatives Study
(CTAS). Volume 6: Computer data. Part 2:
 Residual-fired nocogeneration process boiler
[MASA-CH-159770-PT-2] p0591 #80-33861
GEBERAL ELECTRIC CO., ST. PETRESBURG, FLA.
       Mean wind forces on parabolic-trough solar
            collectors
            [SAND-80-7023]
                                                                                     p0650 N80-32790
 GEBERAL EBERGY ASSOCIATES, CHERRY HILL, N.J.
Relevance of the second law of thermodynamics to
 energy conservation
[DOB/CS-40178/01-VOL-1] p0590 N80-
GENERAL MOTORS CORP., DETROIT, MICH.
An automotive transmission for automotive gas
                                                                                     P0590 N80-33288
turbine power plants
[SAE PAPER 800099] p0736 A80-49
GEORGIA IEST. OF TECH., ATLANTA.
The kinetics of the 02/C02 reaction in molten
carbonate - Eeaction orders for 02 and C02 on
                                                                                     P0736 A80-49724
                                                                                    p0726 A80-48284
       Analytical studies of wind turbine turning
         characteristics [BLO-2439-79/3]
                                                                                     p0753 N80-32951
 GERHABTOWN LABS., INC., PHILADELPHIA, PA.
Investigation of fuels containing coal-oil-water
           emulsions fire tube test apparatus
           [ DOB/ET-10634/T1 ]
                                                                                    P0691 #80-28552
[DOE/ET-10534/T1] POUR BOU-2032

GILBERT/COMMONWEALTH, READING, PA.

Feasibility study: Fuel cell cogeneration in a
water pollution control facility, volume 1
[DOE/ET-1243/T1-VOL-1] p0749 880-31922
[DOE/ET-1243/T1-VOL-1] p0749 880-31922

GILBERT ASSOCIATES, IEC., BRADING, PA.

Research and evaluation of biomass
resources/conversion/utilization systems
(market/experimental analysis for development
of a data base for a fuels from biomass model)
[DOE/ET-20611/11] p0700 880-30552

GRUHHAW AEROSPACE CORP., BETHPAGE, W.I.

Electrochemical photovoltaic cells cdSe thin
film electrodes
           film electrodes
[DSE-4042-T16] P0654 N80-32
GULP RESEARCH AND DEVELOPMENT CO., PITTSBURGH, PA.
                                                                                    p0654 N80-32925
       Refinery energy profile
[ORO-5262-5-SUPPL] p0577 #80-288:
Investigation of mechanisms of hydrogen transfer
                                                                                    p0577 #80-28857
      in coal hydrogenation p0697 M80-29: [PE-2305-33] Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels
            [FE-1800-45]
                                                                                    p0704 #80-31641
       Underground gasification for steeply dipping coal beds. Bawlins test no. 1
       [SAN-13108-35] p0705 N80-316:
Investigation of mechanisms of hydrogen transfer
in coal hydrogenation, phase 2
                                                                                    p0705 N80-31653
           [FB-2305-30]
                                                                                     p0710 N80-32568
                                                          Н
```

HAWTHORNE RESEARCH AND TESTING, INC., CORAL GABLES, Hydrogen engine performance analysis project [SAB-1212-T1] p0665 N80-30756 HONEYWELL, INC., MISBEAPOLIS, MISS.
Installation guidelines for solar heating system, single-family residence at William OBrien State Park, Stillwater, Minnesota [ HASA-CR-161480 ] p0630 N80-28861 Active heat exchange system development for latent heat thermal energy storage [HASA-CB-159727] p0775 H80-29857 Dual curvature acoustically damped concentrating collector p0647 #80-31921 [ DOB/CS-34196/T1] Economic evaluation of the Annual Cycle Energy
System (ACES). Volume 1: Executive summary
[ORHL/SUB-7470/1-V1]
RONEYUELL SYSTEMS AND RESEARCE CENTER, MINUREPOLIS, MINN. High-efficiency concentration/multi-solar-cell system for orbital power generation

p0614 A80-48207

```
CORPORATE SOURCE INDEX
HUGGES ATRCRAFT CO., BL SEGUEDO, CALIF.

Design and flight performance of the Pioneer

Venus Multiprobe and Orbiter solar arrays
                                                                     p0614 A80-48212
      Conceptual design study of concentrator enhanced solar arrays for space applications. 2kW Si and Gals systems at 1 AU
         [ NASA-CR-163046 ]
      Qualification test results of the production
high efficiency K6-3/4 and K7 silicon solar
         cells
                                                                      p0658 N80-33886
EUGHES RESEARCH LABS., MALIBU, CALIF.

Effects of thermal annealing on the deep-level
defects and I-V characteristics of 200 keV
          proton irradiated AlGaAs-GaAs solar cells
                                                                      p0613 A80-48204
      Development of space-qualified Gals solar cells
                                                                      p0658 880-33888
IBM PEDEBAL SYSTEMS DIV., HUBTSVILLE, ALA.
     Solar energy system performance evaluation.
Seasonal report for Colt Pueblo, Pueblo,
         Colorado
         [ NASA-CR-161493 ]
      Solar energy system performance evaluation.
Seasonal report for SEBCO Lincoln, Lincoln,
          Bebraska
         [ NASA-CR-161495 ]
                                                                      p0635 N80-29851
      Solar energy system performance evaluation:
Seasonal report for Contemporary Newman,
Newman, Georgia
         [ NASA-CR-161494 ]
                                                                      p0635 B80-29853
      Solar energy system economic evaluation: IBM
System 2, Togus, Maine
[MASA-CE-161510] p0635 M80-
                                                                      p0635 N80-29854
      Solar energy system performance evaluation:
Seasonal report for Fern Lansing, Lansing,
         Bichigan
      [NASA-CE-161491] p0635 N80-29855
Solar energy system performance evaluation:
Seasonal report for IBM System 1B, Carlsbad,
          New Mexico
         [ NASA-CR- 16 1508 ]
      Solar energy system performance evaluation report for IBM System 4 at Clinton, Mississippi
                                                                     p0641 N80-30893
           NASA-CB-161509]
      Solar energy system economic evaluation final
report for SENCO-Loxahatchee, Loxahatchee
National Wildlife refuge, Palm Beach County,
     [HASA-CR-161512] p0641 N80-30894
Solar energy system performance evaluation
report for IBM System 3, Glendo, Wyoming
[HASA-CR-161520] p0641 N80-30896
     [NASA-CH-101320] poots not Solar energy system economic evaluation for Elcam-Tempe, Tempe, Arizona and Elcam-San Diego, San Diego, California
[NASA-CE-161492] p0644 N86
      [NASA-CE-161492] p0644 N80-31872
Solar energy system performance evaluation.
Seasonal report for Wormser, Columbia, South
                                                                      p0644 N80-31880
         [ NASA-CR- 161546 ]
      Solar energy system performance evaluation:
Seasonal report for Colt Yosemite, Yosemite
Hational Park, California
[NASA-CR-161539] p0645 N80-31883
IDAHO NATIONAL ENGINEERING LAB., IDAHO PALLS.
      Hydrothermal energy: A source of energy for
alcohol production
[CONF-800526-1] p06
IIT RESEARCH IEST., CHICAGO, ILL.
NAVY-New Hampshire wind energy program
                                                                      D0698 N80-29869
                                                                      p0701 B80-30904
         [AD-A086506]
     Design, engineering and evaluation of refractory
liners for slagging gasifiers
```

[ IITRI-M6043-5 ]

[IITEL-MOU43-5]

ILLIMOIS UMIV. AT CHICAGO CIRCLE, CHICAGO.

Single particle gas-solid reactions and their application to modeling of fluidized bed coal combustors and ash agglomerating gasifiers p0713 N80-33578

Energy analysis of geothermal-electric systems [COO-5085-4] p0584 N80-3

ILLIBOIS UNIV. AT URBANA-CHAMPAIGN, URBANA.

p0704 #80-31640

p0584 N80-31915

Sorption properties of sediments and Thermal buffering of receivers for parabolic energy-related pollutants [PB80-189574] p0589 N80-32997 INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.
A hybrid water-splitting cycle using copper sulfate and mixed copper oxides p0664 A80-48503 Gas distribution equipment in hydrogen service -Rlectrochemical photovoltaic cells, project 65021 [DSE-4042-T8] p0742 880-28910 [DSE-4042-18] Process evaluation: Steam reforming of diesel fuel oil p0699 #80-30538 [AD-A087053] Pipeline gas from coal: Hydrogenation (IGT hydrogasification process) [PB-2434-33A] p0703 H80-31630 Pipeline gas from coal: Rydrogenation (IGT time frame hydrogasification process)
[PR-2434-58] p0704 B80-31636 Coal gasification pilot plant support studies
[PE-2806-5] p0704 880-31637 [PB-2806-5] p0704

Development of combustion data to utilize low-Btu gases as industrial process fuels: Modification of flame characteristics p0706 N80-31659 [DOR/ET-14851/2] p0700 Fuel cell research on second-generation molten-carbonate systems p0750 N80-31935 [SAN-11276-2] Synthetic fuels from US oil shales: A technical and economic verification of the HYTORT process [DOB/BT-14102/3] P0710 N80-32567 INSTITUTO DE PESQUISAS ESPACIAIS, SAO JOSE DOS CAMPOS (BRAZIL).

Remote sensing applied to the prospecting of geothermal anomaly in Caldas Hovas County, and sand State of Goias, Brazil
[IMPR-1792-RPK/164] P0712 M80-32837
IMTERMATIONAL HICKEL CO., IMC., SUPPERM, M. Y.
Weld overlaying for corrosion resistance in coal gasification atmospheres [PE-2621-13] P0711 N80-32726 ISRO SATELLITE CESTRE, PERSTA, BANGALORE (INDIA). The power system p0743 N80-29387 JBF SCIENTIFIC CORP., SILMINGTON, MASS. Evaluation of processes for producing gasoline from wood [DOB/PE-70048/T2] p0713 N80-33602 JET PROPULSION LAB., CALIFORNIA INST. OF TECH., PASADENA. Dynamics and control of solar power system
[AIAA 80-1740] p0757 A80-45534
Some characteristics of low-cost silicon sheet p0605 A80-46756 Dynamics and control of a continuum model for a Low cost processes for silicon p0606 A80-46757 A preliminary 'test case' manufacturing sequence systems for 50 cents/watt solar photovoltaic modules in 1986 p0607 A80-46771 Recent developments in the economic modeling of photovoltaic module manufacturing p0607 A80-46773 Testing flat plate photovoltaic modules for terrestrial environment p0608 A80-46788 Physical/chemical modeling for photovoltaic module life prediction p0608 A80-46790 The applicability of DOE solar cell and array technology to space power p0613 A80-48206 Concentrator-enhanced photovoltaic arrays for deep space applications D0614 A80-48210 Salton Sea solar pond project p0617 A80-48362 The JPL parabolic dish project p0618 A80-48417

Comparison of advanced engines for parabolic dish solar thermal power plants

p0618 A80-48418

dish solar thermal power plants Power processing and control requirements of dispersed solar thermal electric generation Heat flux at the thermionic collector Trade-off results and preliminary designs of
Wear-Term Hybrid Vehicles
[SAB PARES 800064] p0772 A80-46222 Vehicles testing of near-term batteries [SAB PAPER 800201] p077 p0773 A80-49730 Photovoltaics in the U.S.A. - A progress report p0629 A80-52866 Solar/hydrogen systems assessment. Volume 1: Solar/hydrogen systems for the 1985 - 2000 Induced junction solar cell and method of fabrication [NASA-CASR-NPO-13786-1] p0634 N80-29 Automotive absorption air conditioner utilizing solar and motor waste heat [ NASA-CASE-NPO-15183] p0634 #80-29843 Electrochemical energy storage systems for solar thermal applications
[NASA-CE-163432] p0636 #80-298 Urban solar photovoltaics potential: An inventory and modelling study applied to the San Fernando Valley region of Los Angeles [NASA-CR-163436] p0636 N80-2989 High temperature thermal energy storage in steel p0636 #80-29859 [ HASA-CB-159708 ] p0776 #80-29860 Intergenerational equity and conservation [NASA-CR-163434] p0580 N80-29861 study of a space communication system for the control and monitoring of the electric distribution system. Volume 1: Summary [NASA-CR-165477] p0760 N80-31 Hybrid vehicle potential assessment. Volume 3: Parallel systems [COMS-4209-T1-VOL-3] p0776 N80-31 p0760 N80-31268 Electric and hybrid vehicle system research and development project: Hybrid vehicle potential assessment. Volume 1: Summary assessment. Volume ... p0583 N80-312
[CONS-4209-T1-V0L-1] p0583 N80-312
Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 4: Series systems p0748 N80-312 PQ583 N80-31272 assessment. Volume 4: Series Systems p0748 N80-312 Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 6: Cost analysis [CONS-4209-T1-VOL-6] p0583 N80-312 Electric and hybrid vehicle system research and development project, hybrid vehicle potential assessment. Volume 8: Scenario generation [CONS-4209-T1-VOL-8] p0583 N80-312 p0748 N80-31273 p0583 N80-31274 [CONS-4209-T1-VOL-8] p0583 N80-31275 A study of industrial hydrogen and syngas supply [NASA-CR-163523] Pilot line report: Development of a high efficiency thin silicon solar cell [BASA-CE-163522] p0644 t p0644 N80-31876 Photovoltaic module electrical termination design requirement study
[JPL-955367-80/1]
methodology for the environmental assessment
of advanced coal extraction systems
[NASA-CR-163570]
p0586 N80-32 p0644 N80-31877 p0586 N80-32827 Improving the efficiency of silicon solar cells containing chromium [NASA-CASE-NPO-15179-1] p0650 880~32850 Low-cost solar array project and Proceedings of the 15th Project Integration Heeting [NASA-CE-163568] p0650 N80-32 p0650 #80-32852 Deep space network energy program p0590 N80-33446 Health requirements for advanced coal extraction systems [ BASA-CR-163625] p0714 R80-34093 JOHES HOPKIES UNIV., DALTIMORE, MD.

Condensation processes in coal combustion products
[DOE/EE-10456/1] p0708 890-32473

p0754 N80-33233

p0691 N80-28554

n0598 A80-46386

p0775 N80-28924

D0589 N80-32997

p0595 A80-45121

p0742 B80-28932

p0697 N80-29524

p0769 A80-48398

P0770 A80-48441

D0704 N80-31640

p0710 180-32572

[ MTI-79TB5 ]

JOINT CENTER POR GRADUATE STUDY, RICHLAND, WASH. Micro-level land use impacts of bioconversion [LA-UR-80-1426] p0709 M80-32562 Plash pyrolysis and gasification of coal through Investigation of low-cost solar cells based on [DOE/ET-23006/3] p0653 N80-32915 laser beating p0711 #80-32573
Assessment of environmental control technologies
for energy storage systems, 1979
[LA-8308-MS] RANSAS UNIV., LAWRENCE.
Spectral effects on direct-insolation
absorptance of five collector coatings
[ASME PAPER 79-817-18] p0597 180-4
KANSAS WATER RESOURCES RESEARCH INST., MARRATTAN. Tokamak poloidal field systems [LA-8375-PR] [LA-8375-PR] p0/54 M8U-33233
Preliminary study of the potential environmental
concerns associated with surface waters and
geothermal development of the Valles Caldera
[LA-8398-MS] p0592 M8U-33969
LOS ANGELES CITI DEPT. OF WATER AND POWER, CALIF. p0597 A80-45722 Solubility of selected major and minor elements from coal and fly ash accumulations [PB80-175334] p0580 H80-29926

KILKERRY, SCOTT AND ASSOCIATES, INC., ARLINGTON, VA.

Documentation of volume 3 of the 1978 Energy
Information Administration annual report to Sun Valley photovoltaic power project, phase 1
[ALO-4281-1] p0633 N80-28909 LUMBUS CO., BLOOMFIELD, B. J.
Development research program for clean congress [DOB/EIA/CR-0456] p0782 B80-328

KVB. IEC.. IRVINE, CALIF.

Determination of air pollutant emission factors for thermal tertiary oil recovery operations p0782 N80-32869 industrial and transportation fuels from coal [FE-2514-31] pO: LUBAR AND PLANETARY INST., HOUSTON, TRX. Scaling and the start-up phase of space in California, volume 1 [PB80-187594] industrialization p0585-N80-31982 Determination of air pollutant emission factors for thermal tertiary oil recovery operations in California. Volume 2: Appendix MAIS (CHARLES T.), IHC., BOSTON, MASS.

Results from study of potential early commercial

MHD power plants and from recent ETP design work p0585 N80-31983 [ PB80-187602] MARTIN MARIETTA ARROSPACE, DENVER, COLO.

Internally insulated thermal storage system LEHIGE UNIV., BETHLEHEE, PA.

Methanol and methyl fuel catalyst

[PE-3177-5]

LIHCOLE COLL., CANTERBURY (NEW ZEALAND).

The potential of energy farming for transport fuels in New Zealand p0708 N80-32472 development program [SAND-80-8175] MARYLAND UNIV., SOLOMORS. Sorption properties of sediments and [PB80-154248] p0693 M80-: The potential of energy farming for transport fuels in New Zealand, appendices p0693 N80-28572 energy-related pollutants
[PB80-189574] PO
MASSACHUSETTS IBST. OF TECH., CAMBRIDGE. A multiple p-n junction structure obtained from as-grown Czochralski silicon crystals by heat [ PB80-154255] p0693 N80-28573 [PB80-154255] p0693 N80-28573
LIHCOLM LAB., MASS. IBST. OF TECH., LEXINGTON.
System design, tests results, and economic
analysis of a flywheel energy storage and
conversion system for photovoltaic applications
[COO-4094-70] p0746 N80-30928
Analytical prediction of liquid
photovoltaic/thermal flat-plate collector treatment - Application to solar cells Momentum theory analysis of unconventional wind extraction schemes, part 10
[ASEL-TR-194-2-PT-10] p0742 M80-28 Peat as a fuel at the proposed Central Marine performance Power Company 600 MW plant, volume 1 [PB80-175185] p06 [COO-4094-66] p0646 N80-31913 Residential photovoltaic flywheel storage system Assessment of integrated urban energy options [PB80-173644] p0581 M80-30234 performance and cost [DOE/ET-20279/92] [PB80-173644] publications [PB80-173644] System design, tests results, and economic analysis of a flywheel energy storage and conversion system for photovoltaic applications [COO-4094-70] p0746 #80-30928 p0587 N80-32874 Analytical prediction of the performance of an air photovoltaic/thermal flat plate collector [DOE/ET-20279/93]
LITTLE (ARTHUR D.), INC., CAMBRIDGE, HASS.
Solar power satellite offshore rectenna study
[HASA-CE-161543]
p0759 880-30891 MASSACHUSETTS UNIV., AMBREST.
Continued evaluation of compact heat exchangers
for OTEC evaluation Large wind turbine generator performance [C00-4238-14] Investigation of the feasibility of using wind power for space heating in colder climates [DOB/DP-03533/T3] p0753 N80-32 assessment [ BPRI-AP-1317 ] P0751 N80-31960 LOCKBERD-CALIFORNIA CO., BURBARK.
Study of methane fuel for subsonic transport p0753 N80-32950 MATERNATICAL SCIENCES HORTEWEST, INC., BELLEVUE, aircraft [ NASA-CR- 159320 ] p0708 N80-32533 Photocell heat engine solar power systems LOCKEED MISSILES AND SPACE CO., SUBMYVALE, CALIF. Large area flexible solar array design for Space MCDONUBLL-DOUGLAS ASTRONAUTICS CO., BUNTINGTON Shuttle application BRACE, CALIF.

Cleaning agents and techniques for concentrating p0615 A80-48214 solar collectors [SAND-79-7052]. Multi-hundred kW solar arrays for space p0617 480-48355 [SAND-79-7052]. p0659 880-33911
MCDONNELL-DOUGLAS ASTRONAUTICS CO., ST. LOUIS, Mo.
Bickel-cadmium batteries for the Modular Power LOS ALAMOS SCIENTIFIC LAB., N. MRX.

Trace element characterization of coal wastes [ PB80-166150 ] p0577 N80-28488 Subsystem Alternative Gas Workshop [LA-8155-C] p0690 H80-28547 Nickel-hydrogen battery integration study for the Multimission Modular Spacecraft Energy savings obtainable through passive solar techniques [LA-UR-80-746] p0632 M80-28891
The dc superconducting power transmission line
project at LASL: US DOE division of electric MCKEE (DAVY) CORP., CLEVELAND, OHIO.

Design, engineering and evaluation of refractory
liners for slagging gasifiers energy systems [LA-8323-PR] [IITRI-M6043-5] p0704 N8
BECHABICAL TECHNOLOGY, INC., LATHAM, B. Y.
Assessment of Synthane mechanical equipment p0759 #80-30656

p0642 N80-30913

LA-UR-80-853]

Performance estimates for attached sunspace passive solar heated buildings

IMMI														
						erf	OFB	ance	ana					20766
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	[OB	0-55	98-	-T 1	] .									32922
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		0-36									p07	80	N80-	32552
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		Vers		002	0.1						~^7	54	×00-	. 22242
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Thermographic techniques applied to solar
       collector systems analysis [SEBI/TP-351-540]
                                                      p0655 #80-32946
    Solar ponds and their applications [SERI/TP-733-617]
    [SERI/TP-733-617] p0655 #80-32947
Performance of storage walls with highly
       conductive covering plates and connecting files
   [SERI/TP-721-574] p0779 E6
Computer modeling of thermal storage walls
                                                      p0779 880-32948
    [SERI/TP-721-610] p0779 B80-3294

Bodel of direct contact heat transfer for latent
                                                      p0779 880-32949
    heat energy storage
[SERI/TP-631-567] p0779 N80
Proceedings of the Ocean Energy Information
                                                       D0779 N80-32955
       Dissemination Workshop
       [ SEBI/TP-732-600 ]
                                                      p0753 N80-32956
    Potential displacement of petroleum imports by solar energy technologies
[SERI/TR-352-504] p0656 N80-3
                                                       p0656 N80-32959
MIDDEST BESEARCH INST., KANSAS CITY, MO.
   Study of thermal energy storage using fluidized
bed heat exchangers
                                                       p0764 A80-48240
    Thermal energy storage systems using fluidized bed heat exchangers
       [ NASA-CR-159868]
                                                       p0775 N80-28866
MISSOURI UNIV. - ROLLA.

Chemical and physical stability of refractories for use in coal gasification
       [COO-2904-15]
MITEE CORP., MCLEAR, VA.
Environmental data energy technology
characteristics: Synthetic fuels
       [DOB/BV-0073]
                                                       p0579 N80-29516
MOBIL RESEARCH AND DEVELOPMENT CORP., PAULSBORG, M.
    Upgrading of coal liquids for use as power
       generation fuels
       [ RPRI-AP-1225]
                                                       p0699 N80-30547
BOTOROLA, INC., CHICAGO, ILL.
Photovoltaic module electrical termination
design requirement study
[JPL-955367-80/1] . p0644 880
BOTOBOLA, INC., PHOEBIX, ARIZ.
Potential for improved silicon ribbon growth
                                                     · p0644 880-31877
       through thermal environment control
                                                      p0601 A80-46704
    Thin film polycrystalline silicon solar cells [SAN-2207-T4] p0638 N80-
                                                       p0638 N80-29879
HOTOROLA, IHC., SCOTTSDALE, ARIZ.
LOW-cost photovoltaic cell mount study
[SAHD-80-7006] p06.
                                                       p0633 N80-28908
MOUND LAB., MIANISBURG, OHIO.
Automated multi-sample gas chromatographic
analysis of fossil fuel gases
              27211
                                                       p0702 N80-31506
MUELLER ASSOCIATES, INC., BALTIMORE, MD.
    Active solar energy system design practice manual [SOLAB/0802-79/01] p0632 N80-2888
                                                       p0632 N80-28889
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    The use of solar energy for cooking
P0659 N80-33953
NATIONAL ACADEMY OF ENGINEERING, WASHINGTON, D. C.
The outlook for nuclear power
[PB80-175755] P0579 M80-29156
HATIOHAL ACADEMY OF SCIENCES. - HATIOHAL RESEARCH
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An improved synthesis of 2,4,8,10-tetroxaspiro
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(5.5) undecane
[NASA-CASE-ARC-11243-2] p0583 N80-31472
HATIOWAL AEROMAUTICAL LAB., BANGALORE (INDIA).
A horizontal axis sail windmill for use in irrigation p0743 N80-29844 [NAL-TN-54] MATICUAL ABROMAUTICS AND SPACE ADMINISTRATION, WASHINGTON, D. C. Progress in space power technology p0722 A80-48173 The SPS concept - An overview of status and outlook p0617 A80-48353 An overview of MASA's participation in the nation's energy program

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Satellite Power Systems (SPS): Concept
       development and evaluation program:
       Preliminary assessment [NASA-TB-81142]
                                                      p0759 N80-29842
    NASA program plan
[NASA-TH-81136]
                                                     p0781 N80-31269
    Composite rotor blades for large wind energy
       installations
    technology for large space systems. A special bibliography with indexes, supplement 3 [BASA-SP-7046(03)]
    WASA technology program overview
p0782 N80-33467

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RESEARCH CENTER, MOFFETT FIRLD, CALIP.

SOLARES orbiting mirror system
[AAS 79-304]
An improved continuous
    An improved synthesis of 2,4,8,10-tetroxaspiro
       (5.5) undecane
[NASA-CASE-ARC-11243-2]
                                                     p0583 N80-31472
HATIONAL ARROHAUTICS AND SPACE ADMINISTRATION.
GODDARD SPACE PLIGHT CENTER, GREENBELT, ND.
Design and performance of the International
       Sun-Earth Explorer power systems
                                                     p0765 A80-48307
    Use of generalized population ratios to obtain
Fe XV line intensities and linewidths at high
       electron densities
p0735 A80-48763

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LYNDON B. JOHNSON SPACE CENTER, HOUSTON, TEL.

Solar power satellites - The present and the future
       future
    p0757 A80-47562
The solar power satellite concept - The past
       decade and the next decade
                                                     p0623 A80-50951
    Riectric propulsion for SPS
                                                     p0643 N80-31466
    Electrochemical Orbital Energy Storage (ECOES)
      technology program
                                                     p0780 N80-33473
HATIONAL ARBONAUTICS AND SPACE ADMINISTRATION.
LANGLEY RESEARCH CENTER, HAMPTON, VA.
Gaas solar cells for space applications
                                                     p0613 A80-48203
NATIONAL ARRONAUTICS AND SPACE ADMINISTRATION.
LEWIS RESEARCH CENTER, CLEVELAND, OHIO.

JT9D-7A /SP/ jet engine performance
       deterioration trends
                                                     p0569 A80-44230
    Experiments on H2-O2 MHD power generation
                                                     P0717 A80-44239
    Spectral effects on direct-insolation
    absorptance of five collector coatings
[ASME PAPER 79-HT-18] p0597 A80-45722
Cycles till failure of silver-zinc cells with
       competing failure modes - Preliminary data
       analysis
                                                     p0761 A80-46414
    Description of photovoltaic village power
       systems in the United States and Africa
    p0609 A80-46796
Energy conservation and environmental benefits
       of thermal energy storage systems in the pulp
       and paper industry
                                                     p0763 A80-48194
    The planar multijunction cell - A new solar cell
       for earth and space
                                                     p0613 A80-48205
    Effect of positive pulse charge waveforms on cycle life of nickel-zinc cells
                                                     p0766 A80-48329
    Power management for multi-100 KWe space systems p0758 A80-48357
    Improvement and scale-up of the NASA Redox
       storage system
                                                     p0767 A80-48370 -
    Cogeneration Technology Alternatives Study
       (CTAS). Volume 2: Analytical approach
[NASA-CR-159766] p0741
                                                     p0741 N80-28859
    Aircraft Research and Technology for Puture Fuels
    [HASA-CP-2146] p0694 N80-29300
Puels research: Puel thermal stability overview p0694 N80-29324
    Some advantages of methane in an aircraft das
       turtine
       [ NASA-TH-81559 ]
                                                     ·p0695 N80-29502
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Rapporteur report: MHD electric power plants
       [MASA-TH-81554] p0743 M80-29862
Improved components for engine fuel savings
[MASA-TH-81577] p0583 M80-31402
The energy efficient engine project
[NASA-TH-81566] p0585 M80-32305
Large wind turbings
       Large wind turbines: A utility option for the generation of electricity
[NASA-TH-81502] p0752 860-32
                                                                                          p0752 N80-32858
       Optimal thermionic energy conversion with established electrodes for high-temperature
            topping and process heating [NASA-TM-81555]
        WIND: Computer program for calculation of three
            dimensional potential compressible flow about
            wind turbine rotor blades
            [ NASA-TP-1729]
                                                                                          D0755 N80-33357
        Synchronous Energy Technology
            [ NASA-CP-2154 ]
                                                                                          p0656 N80-33465
        Synchronous energy technology program
                                                                                         p0657 N80-33466
       Photovoltaic technology development for
            synchronous orbit
                                                                                          p0657 N80-33470
       Toroidal cell and battery
            [ NASA-CASE-LEW-12918-1]
                                                                                          p0780 N80-33857
       MOD-2 wind turbine farm stability study
[NASA-CR-165156] p0755 N80-33862
       Radiation damage in high voltage silicon solar
                                                                                          p0658 N80-33889
NATIONAL ARRONAUTICS AND SPACE ADMINISTRATION.
MARSHALL SPACE PLIGHT CRETER, HUBTSVILLE, ALA.
       Solar thermophotovoltaic space power system
        p0614 A80~48208
Three computer codes to read, plot and tabulate
           operational test-site recorded solar data
[NASA-TM-78293] p0644 N8
                                                                                         p0644 N80-31879
        Large solar arrays
                                                                                          p0657 N80-33471
HATIONAL ARRONAUTICS AND SPACE ADMINISTRATION.
HATIONAL SPACE TECHNOLOGY LABS., BAY SAINT LOUIS,
MISS.
       Energy from wood waste - A case study
p0670 A80-47594 BATIOBAL ABROHAUTICS AND SPACE ADMINISTRATION.
PASADEBA OFFICE, CALIF.

Induced junction solar cell and method of
            fabrication
       [NASA-CASE-NPO-13786-1] p0634 N80-29
Automotive absorption air conditioner utilizing
                                                                                         p0634 880-29835
           solar and motor waste heat
            [ NASA-CASE-NPO-15183]
                                                                                         p0634 N80-29843
       Improving the efficiency of silicon solar cells
            containing chromium
[NASA-CASE-NPO-15 179-1] p0650 N80-32850

MATIONAL BURBAU OF STANDARDS, WASHINGTON, D.C.

Simplified energy design economics: Principles of economics applied to energy conservation and solar energy investments in buildings [PB80-179245] p0634 N80-29534
       Materials for fuel cells
           [PB80-182355]
                                                                                         p0748 N80-30955
       Energy budget procedures and performance
criteria for energy conserving building
illumination systems
[PB80-184229] P0583 N80
NATIONAL MECHANICAL ENGINEERING RESEARCH INST.,
PRETORIA (SOUTH AFRICA).
                                                                                          p0583 N80-31673
       The aerodynamics of contra-rotating axial flow
wind power turbines
[CSIR-ME-1638] p
HATIOBAL TECHNICAL INFORMATION SERVICE,
                                                                                         p0755 N80-33868
SPRINGFIELD, VA.
       Heat pipes. Citations from the NTIS data base
          PRESS CITATIONS FROM the BALL THE PROPERTY OF 
       Heat pipes.
      p0781 B80-28681
Heat pipes. Citations from the Engineering
Index data base
            [PB80-809965]
       Heat pipes. Citations from the engineering
           index data base
            [PB80-809973]
                                                                                         p0781 N80-28683
       Hydrogen production. Citations from the NTIS
           data base
[PB80-810476]
                                                                                          p0665 N80-29519
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[PB80-811094] p0665 N80-30561 Thermionic energy conversion. Citations from	recovery [PB80-169469] p0697 N80-29527
the NTIS data base	NEW MEXICO UNIV., ALBUQUERQUE.
[PB80-810906] p0747 B80-30953 Magnetohydrodynamic generators in power	Automatic-control system for the 17-metre Vertical Axis Wind Turbine (VANT)
generation. Citations from the NTIS data base	[SAND-78-0984] p0750 N80-31958
[PB80-810856] p0748 N80-30954 Wind power. Citations from the NTIS data base	Solar thermal heating and cooling. A bibliography with abstracts
[PB80-811433] p0748 M80-30956	[NASA-CR-163535] p0649 N80-31963
Wind power. Citations from the Engineering Index data base	Biomass energy production. Citations from the International Aerospace Abstracts data base
[PB80-811441] p0748 N80-30957	[PB80-810807] p0711 N80-32578
Synthetic fuels from municipal, industrial, and	Analysis of a passive heat pipe cooled solar photovoltaic receiver
agricultural wastes. Citations from the NTIS data base	[SAND-80-7011] p0651 N80-32885
[PB80-811375] p0706 N80-31660	Forecasts of energy technology. Citations from
Wind power. Citations from the NTIS data base [PB80-811458] p0751 N80-31965	the International Aerospace Abstracts data base [NASA-CR-163596] p0782 N80-32965
Synthetic fuels from municipal, industrial and	NEW ZEALAND ENERGY RESEARCH AND DEVELOPMENT
agricultural wastes. Citations from the American Petroleum Institute data base	COMMITTEE, AUCKLAND.  The potential of energy farming for transport
[PB80~812365] p0711 N80-32579	fuels in New Zealand
Alcohol fuels. Citations from the Engineering Index data base	[PB80-154248] p0693 N80-28572 The potential of energy farming for transport
[PB80-812449] p0711 N80-32581	fuels in New Zealand, appendices
Alcohol fuels. Citations from the Engineering Index data base	[PB80-154255] p0693 N80-28573 Automotive fuels from cellulose materials
[PB80-812456] p0711 N80-32582	[NZERDC-49] p0710 N80-32571
Lithium batteries. Citations from the BTIS data base	NORL PRHMY TURBINES LTD., TOLL BAR BED (EMGLAND).  Requirements for materials for land vehicle gas
[PB80-812399] p0779 N80-32967	turbines
Lithium batteries. Citations from the	p0743 N80-29345
Engineering Index data base [PB80-812407] p0779 N80-32968	Coal gasification/gas cleanup test facility:
Hydrogen use as a fuel. Citations from the NTIS	Volume 1. Description and operation [PB80-188378] p0707 N80-31990
data base [PB80-813090] p0667 N80-33607	[PB80-188378] p0707 N80-31990
State-of-the-art reviews and bibliographies on	Photochemical study of NOx removal from stack
energy. Citations from the NTIS data base [PB80-812886] p0782 N80-33917	gases [PB80-181274] p0582 N80-30966
State-of-the-art reviews and bibliographies on	BORTH DAKOTA STATE DEPT. OF HEALTH, BISHARCK.
energy. Citations from the NTIS data base [PB80-812894] p0782 N80-33918	The long-term effects of trace elements emitted by energy conversion of lignite coal
Lead batteries. Citations from the NTIS data base	[PB80-168867] p0578 N80-28958
[PB80-813363] p0780 N80-33923 Lead batteries. Citations from the Engineering	The long-term effects of trace elements emitted by energy conversion of lignite coal. Volume
Index data base	2: Technical appendices
[PB80-813371] p0780 N80-33924 Technology Assessment. Citations from the NTIS	[PB80-168875] p0579 N80-28960 NORTH DAKOTA UNIV., GRAND FORKS.
data base	Chemistry of lignite liquefaction
[PB80-813165] p0783 N80-34299 Technology Assessment. Citations from the NTIS	[FE-2211-11] p0704 N80-31642 NORTHWESTERN UNIV., EVANSTON, ILL.
data base	Combustion studies of coal-in-oil droplets
[PB80-813173] p0783 N80-34300 ATIONAL BRATHER SERVICE, SALT LAKE CITY, GTAH.	[DOE/ET-10660/1] p0702 N80-31499
The SWAB (Spectral Wave And Bar) program	0
[PB80-196041] p0714 N80-34052 AVAL CIVIL ENGINEERING LAB., PORT HUENEMB, CALIF.	OAK RIDGE ASSOCIATED UNIVERSITIES, TENH.
Solar heating of buildings and domestic hot water	Assessment of industrial energy conservation by
[AD-A085815] p0634 h80-29532 AVAL RESEARCH LAB., WASHINGTON, D. C.	unit processes [ORAU/IEA-80-4(M)] p0584 N80-31939
OTEC cold water pipe design for problems caused	Constraints on carbon dioxide production from
by vortex-excited oscillations [AD-A084555] p0741 N80-28867	fossil fuel use [ORAU/IEA-80-9(M)] p0589 M80-32983
Energy storage as heat-of-fusion in	OAK RIDGE GASEOUS DIFFUSION PLANT, TENN.
containerized salts. Report on energy storage boiler tank	Review of Department of Energy sponsored codes and documentation available from Purdue and
[AD-A087753] p0777 N80-32862	Lehigh Universities processes modeling contracts
AVAL SURFACE WEAPONS CENTER, WHITE OAK, HD. Thermelectric materials for solar energy	[K/CSD/TM-35] p0707 N80-32276 OAK BIDGE HATIOBAL LAB., TENN.
conversion	Plasma-sprayed coatings for very high
[AD-A084948] p0631 N80-28869 BBRASKA UNIV LINCOLN.	temperature solar absorbers [CONF-791021-3] p0631 N80-2887
Pseudo-shock as a qualitative model in the	Roof overhang design for solar control
investigation of the influence of wall roughness on the performance of supersonic MHD	[CONF-791022-15] p0632 N80-28900 Environmental constraints on geothermal energy
generators	[ORNL-1310] p0580 N80-2986
[AD-A088333] p0754 N80-33228 BW EMGLAND RIVER BASINS COMMISSION, BOSTOB, MASS.	Passive solar heating and natural cooling of an earth-integrated design
Potential for hydropower development at existing	[CONF-800449-1] p0638 N80-29884
dams in New England Volume 1: Physical and	Overview of nuclear fuel cycle
economic findings and methodology [PB80-169121] p0578 N80-28934	[CONF-791185-3] p0698 N80-3017 Simultaneous photoproduction of hydrogen and
Potential for hydropower development at existing	oxygen by photosynthesis
dams in New England. Volume 2: User's manual [PB80-169139] p0578 N80-28935	[CONF-791072-32] p0665 N80-30550 Thermally driven open-cycle heat pump system
	[CONF-800549-11 p0582 N80-30938

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Advanced designs for highly stable
                                                                                                                                   PACIFIC MISSILE TEST CENTER, POINT MUGU, CALIF.
            superconductor systems
                                                                                                                                          Pacific Missile Test Center energy projects.
                                                                                                                                   Summary of projects, contributions, and plans
[AD-A086196] p0581 M80-30903
PAN ARBRICAN WORLD AIRWAYS, INC., JAMAICA, B. Y.
JT9D-7A /SP/ jet engine performance
deterioration trends
       [CONF-791102-148] p0748 | Possil fuels research matrix program. US
                                                                                   p0748 N80-31253
            Environmental Protection Agency/Department of
            Energy Possil Fuels Research Materials Facility
[ORNL/TM-7346] p0583 N80-316
                                                                                   p0583 #80-31632
       Possil energy program
[ORNL-5630]
                                                                                                                                   PATENT AND TRADEMARK OPPICE, WASHINGTON, D. C.
       [ORMI-5630] p0707 M80-31902
Modeling and evaluation of designs for solid
                                                                                                                                   Patent profiles: Solar energy [PB80-190010] p0649 H80-31966
PBBBSILVANIA STATE UNIV., UNIVERSITY PARK.
Controlled cadmium telluride thin films for
           hydrogen storage beds
[CONF-800616-8]
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       Comparison of solar-thermal and fossil
            total-energy systems for selected industrial
                                                                                                                                             solar cell applications (emerging materials
                                                                                                                                             systems for solar cell applications)
[DOE/ET-23023/T3] p06
            applications
                                                                                                                                   [DOE/ET-23023/T3] p0642 N80-30921
PHILLIPS CARBON BLACK CO. LTD., PORT BLIZABETE
(SOUTH APPTCL)
            [ORNL/TH-7022]
                                                                                   p0586 M80-32871
       Thermal energy storage for building heating and cooling applications [ORBL/TH-7319] p0777 M80-32
                                                                                                                                    (SOUTH APRICA).
                                                                                   p0777 N80-32879
                                                                                                                                         Energy conservation-air pollution abatement
       Annual Cycle Energy System (ACES)
                                                                                                                                             project
           [ORNL/CON-42]
                                                                                   p0587 N80-32880
                                                                                                                                                                                                                     p0592 N80-33939
       Seasonal thermal energy storage
[PHI-3322] p0778 N89
Theory and design of an Annual Cycle Energy
                                                                                                                                   PRILLIPS PRIROLEUM CO. BUROPE-APRICA, LONDON
                                                                                   p0778 B80-32899
                                                                                                                                    (EEGLAED)
                                                                                                                                         Pield experiences with rotordynamic instability
           System (ACES) for residences [ORBL/CCB-43]
                                                                                                                                             in high-performance turbomachinery
                                                                                                                                                                                                                    P0697 N80-29707
                                                                                   p0587 N80-32904
       Appraisal of the M factor and the role of
building thermal mass in energy conservation
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            [OBBL/COB-46]
                                                                                   P0588 N80-32958
       Development of an energy consumption and cost
data base for fuel cell total energy systems
and conventional building energy systems
                                                                                                                                              data analysis and predictions
                                                                                                                                         (AETC-8450-T1] p0701 N80-3090

Coal processing for fuel cell utilization: Task

9: One-dimensional (streamtube) model for
entrained-flow gasifier analysis
[METC-8450-T2-V0L-1] p0707 N80-3191
                                                                                                                                                                                                                     p0701 N80-30909
[ORBL/CON-38] p0754 880-32960
OPFICE OF TECHNOLOGY ASSESSMENT, WASHINGTON, D. C.
Alternative energy futures. Part 1: The future of liquefied natural gas imports
[PB80-173552]
                                                                                                                                                                                                                    p0707 N80-31912
                                                                                                                                   PITTSBURGE UNIV., PA.
                                                                                                                                         Hydrogen distribution and transfer in coal
       The direct use of coal. Volume 2, part 1:
Working papers, appendices 1-4
[PB80-184518] p0697 B
                                                                                                                                   hydrogenation systems
[DOE/PC-30014/1]
POLYTECHNIC INST. OF HEW YORK.
                                                                                                                                                                                                                    p0758 N80-29473
                                                                                   p0697 N80-29520
       The direct use of coal. Volume 2, part B:
                                                                                                                                         Optimum systems design with random input and
           Working papers, appendices 7-9 [PB80-184526]
                                                                                                                                             output applied to solar water heating
                                                                                   p0697 N80-29521
                                                                                                                                                                                                                    p0657.N80-33854
      [PB80-184526] P0697 N80-2
The direct use of coal. Volume 2, part C:
Working papers, appendices 10-14
[PB80-184534] P0697 N80-2
Working papers, appendices 15-17
[PB80-184542] P0697 N80-2
Conservation and solar energy programs of the Department of Energy: A critique
[PB80-197759] P0591 N80-3
                                                                                                                                   POLYTECHNIC INST. OF BRH YORK, BROOKLYN.
                                                                                                                                         Department of Housing and Urban Development
solar hot water initiative: Centralized
coordination of technical tasks and system
                                                                                   p0697 N80-29522
                                                                                                                                             evaluation
                                                                                                                                  POBSCHE (PERDINAND) AG, STUTTGART (MEST GRAMAN).
Reduction of fuel consumption by thermodynamic optimization of the Otto motor: Comparative
                                                                                   p0697 N80-29523
           [PB80-197759]
                                                                                   p0591 N80-33922
OHIO STATE UNIV., COLUMBUS.

A new probabilistic simulation technique for multiple energy storage devices for electric
                                                                                                                                          investigation of Otto diesel engines [EUR-6711-DE] p05
                                                                                                                                  [EUR-6711-DE] p0585 N80-32733
PRATT ABD WHITHEY AIRCRAFT, WEST PALM BRACH, PLA.
                                                                                                                                         Advanced combustion systems for stationary gas
turbine engines. Volume 4: Combustor
verification testing, addendum
            utility generation system expansion planning
           models
                                                                                   p'0774 N80-28855
OKLAHOMA STATE UNIV., STILLWATER.
Catalysts for upgrading coal-derived liquids
[DOE/ET-14876/2] p0691 N80
                                                                                                                                             [PB80-179849]
                                                                                                                                                                                                                    p0698 N80-30313
                                                                                                                                   PRATT AND WHITNEY AIRCRAFT GROUP, BAST HARTFORD,
                                                                                   p0691 N80-28556
                                                                                                                                  CONN.
OKLAHOMA UNIV., NORMAN.
Combustion of drops and sprays of no. 2 diesel
oil and its emulsions with water and methanol.
                                                                                                                                        JT9D-7A /SP/ jet engine performance
deterioration trends
                                                                                                                                  p0569 A80-44230 PRATT AND WEITHEY AIRCRAPT GROUP, WEST PALE BEACH,
           Volume 1: Exp
[PB80-178213]
                                  Experimental
      Combustion of drops and sprays of no. 2 diesel oil and its emulsions with water and methanol. Volume 2: Theoretical [PB80-178221] p0698 N80-304
                                                                                                                                         Advanced combustion systems for stationary gas
                                                                                                                                             turbine engines. Volume 2: Bench scale evaluation
                                                                                                                                             [ PB80-175607]
                                                                                   D0698 N8G-30471
                                                                                                                                                                                                                    p0744 N80-29922
OLD DOMINION UNIV., NORPOLK, VA.
Gals solar cells for space applications
                                                                                                                                  PEC BUERGY ANALYSIS CO., MCLEAR, VA.
                                                                                                                                         Some questions and answers about the Satellite
                                                                                  p0613 A80-48203
                                                                                                                                             Power System (SPS)
OPTICAL COATING LAB., INC., SANTA ROSA, CALIF.
An evaluation of spectrally selective reflectors
(cold mirror membranes) for use with
                                                                                                                                  [NASA-CR-163329] PO63
PBC SYSTEMS SERVICES CO., HUBISVILLE, ALA.
                                                                                                                                                                                                                    p0639 N80-29897
                                                                                                                                        Design, performance and life cycle cost
relationships for a 500kW space solar array
p0617 A80-48356
           concentrator solar arrays
                                                                                   p0659 N80-33900
                                                                                                                                  PRINCETON UNIV., N. J.

Pormation and control of fuel-nitrogen
pollutants in catalytic combustion of
OREGOE STATE UNIV., CORVALLIS.

Vegetation as an indicator of high wind velocity
[RLO-2227-T24-79/1] p0694 880-289
                                                                                                                                             coal-derived gases
                                                                                                                                  [PE-2762-8] p0577 N80-28:
PROTOTECH, INC., BENTON HIGHLANDS, MASS.
Energy savings by means of fuel cell electrodes
                                                                                                                                                                                                                    P0577 N80-28557
PACE CO. CONSULTANTS AND ENGINEERS, INC., DENVER,
                                                                                                                                             in electro-chemical industries
      Coal liquefaction [DOE/FE-0003/79-2]
                                                                                                                                             [C00-4881-12]
                                                                                                                                                                                                                     p0745 N80-30902
                                                                                   p0711 N80-32574
```

CORPORATE SOURCE INDEX SABDIA LABS.,

PUBLIC SERVICE ELECTRIC AND GAS CO., MEMARK, M. J.	. Solar Central Receiver Hybrid Power Systems
Peasibility study: Fuel cell cogeneration in a	sodium-cooled receiver concept. Volume 2, book 1: Conceptual design, sections 1 through 4
water pollution control facility, volume 1 [DOB/RT-12431/T1-VOL-1] p0749 B80-31922	[DOR/ET-20567/1-2-BK-1] p0645 880-31896
District heating and cooling systems for	Solar Central Receiver Hybrid Power Systems
communities through power plant retrofit distribution network, volume 4	sodium-cooled receiver concept. Volume 2, book 2: Conceptual design, sections 5 and 6
[COO-4977/1-VOL-4] P0753 H80-32942	[DOB/ET-20567/1-2-BK-2] p0645 N80-31897
PURRTO RICO OFFICE OF EMBRGY, SANTURCE.  Concentrating photovoltaics for the tropics	Solar central receiver hybrid power systems sodium-cooled receiver concept. Volume 1;
[DOB/CS-04270/1] p0656 H80-32954	Executive summary
PURRTO RICO UBIV., HAYAGUEZ.  Design of land-based, foam OTEC plants for	[DOR/ET-20567/1-1] p0648 H80-31948 BOCKWELL INTERNATIONAL CORP., DOWNEY, CALIF.
bottoming cycles	Satellite Power Systems (SPS) concept definition
[COMP-790631-17] p0742 M80-28913	study. Volume 7: System/Subsystem
PUBRIO BICO UNIV., RIO PIEDRAS.  Production of sugarcame and tropical grasses as	requirements data book [MASA-CR-3324] p0759 N80-30900
a renewable energy source	Satellite power systems (SPS) concept definition
[ORO-5912-T3]. p0699 N80-30543	study. Volume 1: Executive summary [NASA-CR-3317] p0759 N80-30901
R	Satellite power systems (SPS) concept definition
R AND D ASSOCIATES, MARINA DEL REY, CALIP.	study. Volume 2, part 1: System engineering [NASA-CR-3318] p0760 N80-31890
Perspectives on research on LNG Vapor cloud	Satellite Power Systems (SPS) concept definition
dispersion p0590 M80-33593	study. Volume 6: In-depth element investigation
RADIAH CORP., AUSTIN, TEX.	[NASA-CR-3323] p0651 N80-32859
Environmental assessment report: Wellman-Galusha low-Btu gasification systems	Satellite power system (SPS) concept definition study. Volume 3: Experimental verification
[PB80-190796] . p0589 N80-32995	definition
Stack gas reheat evaluation	[NASA-CR-3320] p0651 N80-32860
[PB80-196850] p0593 B80-33980 RAND CORP., SANTA HONICA, CALIP.	Satellite Power Systems (SPS) concept definition study. Volume 5: Special emphasis studies
A quantitative evaluation of closed-cycle ocean	[NASA-CR-3322] p0651 N80-32861
thermal energy conversion (OTEC) technology in central station applications	ROCKWELL INTERNATIONAL CORP., GOLDRE, COLO. Altos-model 8B wind turbine generator. Failure
[R-2595-DOB] p0749 N80-31885	analysis
RASOR ASSOCIATES, INC., SUNHIVALE, CALIP.  Collector temperature effects on the performance	[RPP-3035/3533/79-10] p0742 N80-28925 Altos-model 8B wind turbine generator.
of advanced thermionic converters and nuclear	Performance report
electric propulsion systems p0730 A80-48421	[BPP-3033/3533/79-4] p0742 N80-28926 Rocky Plats Small Wind Systems Test Center
BCA LABS., PRINCETON, N. J.	activities. Volume 1: Atmospheric test data
Amorphous thin films for solar-cell applications [DOE/ET-21074/4] p0653 N80-32921	collected from Small Wind Energy Conversion Systems
RESEARCH TRIANGLE INST., RESEARCH TRIANGLE PARK, N.	[BPP-3004-VOL-1] p0746 N80-30907
C. Pollutants from synthetic fuels production:	Rocky Flats Small Wind Systems Test Center activities. Volume 2: Controlled velocity,
Coal gasification screening test results	vibration and dynamometer testing of Small
[PB60-162769] p0707 N80-31986	Wind Energy Conversion Systems [RPP-3004-VOL-2] p0746 N80-30908
Environmental protection of the solar power	Sencenbaugh: Model 1000-14 wind turbine generator
satellite p0609 A80-46899	[RPP-3034/3533/79-5] p0746 N80-30931 Small Wind Turbine Systems 1979: A Workshop on
Solar power satellite offshore rectenna study	R and D Requirements and Utility
[NASA-CR-161543] p0759 N80-30891	Interface/Institutional Issues. Volume 1: R and D requirements
A computer model of solar panel-plasma interactions	[RFP-3014-VOL-1] p0747 N80-30943
[NASA-CE-160796] p0650 N80-32853 ROCKET RESEARCH CORP., REDHOUD, WASH.	ROCKUELL INTERNATIONAL CORP., SEAL BRACH, CALIF.  Heat-rejection design for large concentrating
Sulfuric acid and water chemical heat	solar arrays
pump/chemical energy storage program, phase 2-A [SAND-78-8176] p0776 N80-30924	p0614 A80-48211 ROCKWELL INTERNATIONAL CORP., THOUSAND OAKS, CALIF.
[SAND-78-8176] p0776 N80-30924 Chemical energy storage for solar thermal	Advanced photovoltaic concentrator cells
conversion	[DSE-4042-T30] p0643 M80-30946 Advanced photovoltaic concentrator cells
[SAND-79-8198] p0652 B80-32889 BOCKWELL INTERNATIONAL CORP., ABAHRIM, CALIF.	[DSE-4042-T40] p0645 N80-31904
Thin films of InP for photovoltaic energy	Gallium arsenide photovoltaic dense array for
conversion [COO-3004-2] p0642 N80-30912	concentrator applications [SAND-80-1569C] p0654 N80-32936
ROCKWELL INTERNATIONAL CORP., CANOGA PARK, CALIF.	Gallium arsenide photovoltaic dense array for
Partial liquefaction of coal by direct hydrogenation	concentrator applications
[FE-2044-51] p0699 N80-30540	[SAND-79-2270C] p0655 N80-32938
	BOCKBELL INTERNATIONAL SCIENCE CENTER, THOUSAND
Molten salt coal gasification process development unit	BOCKWELL INTROVATIONAL SCIENCE CENTER, THOUSAND OAKS, CALIF.
development unit [SAN-1429-52] p0700 N80-30554	BOCKBELL IMPREMATIONAL SCIENCE CENTER, THOUSAND OAKS, CALIF. Study program for encapsulation materials interface for low cost milicon solar array
development unit [SAN-1429-52] p0700 N80-30554 Molten salt coal gasification process	BOCKBELL IMPREMATIONAL SCIENCE CENTER, THOUSAND OAKS, CALIF. Study program for encapsulation materials interface for low cost milicon solar array [NASA-CR-163583] p0651 N80-32857
development unit [SAB-1429-52] p0700 N80-30554  Molten salt coal gasification process development unit [SAB-1429-56] p0703 N80-31631	BOCKBELL IMPREMATIONAL SCIENCE CENTER, THOUSAND OAKS, CALIF. Study program for encapsulation materials interface for low cost milicon solar array
development unit  [SAN-1429-52] p0700 N80-30554  Molten salt coal gasification process  development unit  [SAN-1429-56] p0703 N80-31631  Advanced development of a short-residence-time	BOCKBELL INTERBRATIONAL SCIENCE CENTER, THOUSAND OAKS, CALIF.  Study program for encapsulation materials interface for low cost milicon solar array [NASA-CR-163583] p0651 N80-32857
development unit [SAN-1429-52] p0700 N80-30554  Molten salt coal gasification process development unit [SAN-1429-56] p0703 N80-31631  Advanced development of a short-residence-time hydrogasifier [FE-3125-12] p0704 N80-31638	BOCKBELL IMPREMATIONAL SCIENCE CENTER, THOUSAND OAKS, CALIF. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32857  SAUDERS ASSOCIATES, INC., BASHUA, N. H. Small solar electric system components
development unit  [SAB-1429-52] p0700 N80-30554  Nolten salt coal gasification process development unit  [SAB-1429-56] p0703 N80-31631  Advanced development of a short-residence-time hydrogasifier  [FE-3125-12] p0704 N80-31638  Advanced development of a short-residence-time	BOCKBELL IMPREMATIONAL SCIENCE CENTER, THOUSAND OAKS, CALIF.  Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32857  SANDERS ASSOCIATES, INC., MASHUA, N. H. Small solar electric system components demonstration
development unit [SAN-1429-52] p0700 N80-30554  Molten salt coal gasification process development unit [SAN-1429-56] p0703 N80-31631  Advanced development of a short-residence-time hydrogasifier [FE-3125-12] p0704 N80-31638	BOCKBELL IMPREMATIONAL SCIENCE CENTER, THOUSAND OAKS, CALIF. Study program for encapsulation materials interface for low cost silicon solar array [NASA-CR-163583] p0651 N80-32857  SAUDERS ASSOCIATES, INC., HASHUA, N. H. Small solar electric system components demonstration [NASA-CR-163513] p0644 N80-31875 SAUDIA LABS., ALBUQUERQUE, N. MEX.
development unit [SAN-1429-52] p0700 N80-30554  Nolten salt coal gasification process development unit [SAN-1429-56] p0703 N80-31631  Advanced development of a short-residence-time hydrogasifier [FE-3125-12] p0704 N80-31638  Advanced development of a short-residence-time hydrogasifier	ROCKBELL IMPERBATIONAL SCIENCE CENTER, THOUSAND OAKS, CALIF. Study program for encapsulation materials interface for low cost milicon solar array [NASA-CR-163583] p0651 N80-32857  S SANDERS ASSOCIATES, INC., BASHUA, N. H. Small solar electric system components demonstration [NASA-CR-163513] p0644 N80-31875

```
Comparison with strain gage data of centrifugal
stresses predicted by finite element analysis
on the DOB/Sandia 17 m Darrieus turbine
                                                                                          SOCIETE . MATIONALE INDUSTRIBLE AREOSPATIALE, CASHES
                                                                                           IPRANCEL .
                                                                                               SPOT solar array
        [SAND-79-1990]
                                                         p0741 #80-28756
     Magma energy: A feasible alternative
[SAND-80-0309] p0693 N80-28874
Analysis of the influence of geography and
                                                                                           SOCIETE BATIONALE INDUSTRIBLE AREOSPATIALE, LES
                                                                                          MURRAUX (PRANCE).

The SHIAS magnetic bearing wheel
                                                                                                                                                   p0775 N80-28929
        weather on parabolic trough solar collector
                                                                                                 [SHIAS-792-421-101]
                                                                                               Passive radially centered magnetic suspension
        design
        [SAND-79-2032]
                                                         p0631 N80-28876
                                                                                                 for high velocity rotors [SBIAS-792-422-109]
     Hultiple-tank high temperature storage subsystem
[SAND-79-2056] p0775 880-28878
                                                                                                                                                   p0775 880-28930
                                                                                               Example of a policy aimed at increasing the value of spin-offs from space technology in
     Concentrating solar collector test results
     [SABD-80-0801C] p0633 B80-28912
Survey of selective solar absorbers and their
limitations
                                                                                                  other fields
                                                                                           [SBIAS-601-422-101] p0782 880-32297 SOCIETE BATIOFALE INDUSTRIELLE AEROSPATIALE, PARIS
         SAND-79-2371C]
                                                          p0639 N80-29889
                                                                                           (PRANCE) -
     Utility views on solar thermal central receivers [SAND-80-8203] p0642 H80-309
                                                                                               Aerospace technology transfer
                                                                                                 [SNIAS-792-422-112]
                                                         p0642 N80-30911
                                                                                                                                                   p0579 B80-29210
    [SAND-00-0203]
Photovoltaic systems and applications perspective
[SAND-80-0926C] p0582 880-30923
                                                                                           SOLAR BUVIRONMENTAL ENGINEERING CO., INC., PORT
                                                                                          COLLIES, COLO.

Solar index generation and delivery
[DOE/ET-20090/3] p0654 H80

SOLAR TURNIES INTERNATIONAL, SAN DIEGO, CALIP.
     [SAND-80-0926C] p0582 N8
Performance data for a lithium-silicon/iron
       disulfide, long-life, primary thermal battery
[SAND-79-2148C] p0746 880-30
                                                                                                                                                   p0654 H80-32929
    ISAND-79-2148C) p0746 880-30933
Instrumentation and process control development
for in situ coal gasification
[SAND-80-1025]
                                                                                               Development of polyimide materials for use in
                                                                                                 solar energy systems [DOE/CS-35305/T2]
                                                                                                                                                   p0636 N80-29870
     Thermal energy storage for solar thermal
                                                                                               Automotive storage of hydrogen using modified
     applications program
[SAND-80-8218] p0646
Field experience with solar concentrating
                                                                                                 magnesium hydrides
                                                         p0646 B80-31918
                                                                                                                                                   p0666 N80-31650
                                                                                          SOLABER CORP., ROCKVILLE, HD.
Pilot line report: Development of a high
efficiency thin silicon solar cell
[HASA-CE-163522] p0644 1
     collector control systems
[SAND-79-2044C]
Analytical evaluation of a solar
                                                         D0647 N80-31924
                                                                                                                                                   D0644 N80-31876
                                                                                              Investigation of the impurity tolerance of semicrystalline silicon solar cells silicon
        thermophotovoltaic converter
        SAND-78-1962]
    [SAND-78-1962] p0649 M80-31954 Catalyst characterization in coal liquefaction
                                                                                          impact program
[DOB/CH-00178/T2] p0654 B80-329
SOUTH DAKOTA UBIV., VERHILLION.
Passive solar heating of buildings with attached
                                                         p0709 N80-32560
       [SAND-80-0123]
                                                                                                                                                   p0654 N80-32934
     Photovoltaic applications definition and
       photovoltaic system definition study in the agricultural sector. Volume 2: Technical
                                                                                                  greenhouse
                                                                                                  [ DOB/CS-30242/2 ]
    Analysis of a passive heat pipe cooled solar photovoltaic receiver
                                                                                           SOUTHERN CALIFORNIA EDISON CO., ROSENBAD.
                                                                                               Salton Sea solar pond project
                                                                                                                                                   D0617 A80-48362
        [ SAND-80-7011]
                                                                                          SPECTROLAB, INC., SYLMAR, CALIP.
Coplanar back contacts for thin silicon solar
                                                          p0651 N80-32885
    Line-focus solar thermal energy technology
development. Report for Department 4720
[SAND-80-0865-REV] p0651 B
                                                                                                  cells
                                                         p0651 #80-32887
                                                                                                 [ NASA-CR-159811]
                                                                                                                                                   p0630 #80-28860
     Pluid temperature control for parabolic trough
                                                                                               Thin, high efficiency silicon solar cells
                                                                                          SRI INTERNATIONAL CORP., MENLO PARK, CALIF.
Shift conversion and methanation in coal
gasification: Bench-scale evaluation of a
       solar collectors [SABD-79-2006C]
                                                         p0652 N80-32894
     Parabolic trough solar collector wind loading
    [SAND-79-2134C] p0652 #80-32895
Research and development for inertial energy
                                                                                                 sulfur resistant catalyst [PB-3240-T4]
                                                                                                                                                   p0692 N80-28561
       storage based on a flexible flywheel
       [SABD-79-7097]
                                                         p0778 #80-32898
                                                                                               Shift conversion and methanation in
                                                                                                                                                    coal
    US National Photovoltaics Program and
                                                                                                 gasification: Bench-scale evaluation of a
       applications experiments in the intermediate
                                                                                                  sulfur resistant catalyst
                                                                                              [FE-3240-15] p0696 M80-29509
Direct electrochemical generation of electricity
        sector
        [SAND-80-0587C]
                                                         p0654 #80-32935
    Gallium arsenide photovoltaic dense array for concentrator applications
                                                                                                 from coal
                                                                                                  [ SAN-0115-105-11
                                                                                                                                                   p0752 N80-32865
                                                                                          Line-focus solar central power system, phase 1.
Subsystem experiment: Receiver heat transfer
[DOB/ET-20550/1] p0655 M80-329
STAMPORD OBJEV., CALIF.
Joule heating effects in the electrode wall
        [SAND-80-1569C]
     Simple economic evaluation and applications
        experiments for photovoltaic systems for
                                                                                                                                                   p0655 880-32945
        remote sites
        [SAND-80-0749C]
Pulsed power accelerators for particle beam fusion [SAND-80-0550C] p0715 880-34239
SANTA CLARA UNIV., CALIF.
Methanol/ethanol/gasoline blend fuels
                                                                                                 boundary layer of MHD generators
                                                                                              geological and geothermal data use
                                                                                                 investigations for application Explorer
       demonstration with stratified charge engine
                                                                                                 mission-A (heat capacity mapping mission)
        vehicles
                                                                                                                                                   p0698 N80-29822
       [PB80-192123]
                                                                                               Market penetration of energy supply technologies
                                                         p0713 N80-33606
SCIERCE APPLICATIONS, IEC., RALEIGH, E.C.
South Atlantic OCS physical oceanography, volume 2
[PB80-181555]
p0582 M80-31026
                                                                                                                                                   p0579 880-29837
                                                                                          STATE UNIV. OF MEN YORK, BUFFALO.

Deposition, fabrication and analysis of polycrystalline silicon MIS solar cells
    South Atlantic OCS physical oceanography, volume 3 [PB80-181563] p0583 N80-31027
[PB80-181563] p0583 N80-31
SKELLY ABD LOY, HARRISBURG, PA.
General application of the critical path method
                                                                                                                                                   p0653 N80-32920
                                                                                                  [DOB/BT-23044/4]
                                                                                          STEPHERS COLL., COLUMBIA, HO.
Solar space heating for the Visitors Center,
Stephens College, Columbia, Hissouri
       to resource characterization and planning for
                                                                                          STORE AND WEBSTER ENGINEERING CORP., BOSTON, MASS.

Hydroprocessing of light pyrolysis fuel oil for kerosene type jet fuel

[AD-A089101] p0713 880-33599
        underground coal mining
[DOB/ET-11268/3] p0707 H80-32:
SOCIETE EUROPEENEE DE PEOPULSION, VERNON (PRANCE).
                                                         p0707 H80-32272
    Study on the utilization of solar energy for the operation of Spacelab material science furnaces [BSA-CR(P)-1301] p0640 M80-30348
```

p0777 N80-32856

p0755 #80-33856

p0714 N80-33988

p0729 A80-48387

p0732 A80-48476

p0746 N80-30934

p0705 N80-31653

p0633 N80-28928

p0639 N80-29899

p0694 H80-29303

p0752 #80-32722

p0750 #80-31938

p0752 N80-32877

p0713 880-33601

STRUCTURAL COMPOSITES INDUSTRIES, IEC., ARUSA, CALIP. TRIAS OBIV., AUSTIN. Low cost composite materials for wind energy A study of the applicability/compatibility of inertial energy storage systems to future conversion systems D0717 A80-44104 space missions STOTIGARY UNIV. (URST GERHANI).
Static investigation of rotor blades at rest and [BASA-CR-163584] TRIAS CRIV. AT AUSTIN. Monitoring of the performance of a solar heated and cooled apartment building [DSE-5235-T1] p0653 B80-32 under quasi-stationary loading [ISD-243] p0747 880-30948 [15D-243]
Stability and dynamic response to gravitational forces of the flapping and lead-lag hinges on a rigid rotor blade with the leading-edge angle of attack and flapping being coupled Modeling of heat and mass transfer during coal block qasification p0713 880-33577 Evaluation of hydropower potential in a river p0747 880-30949 Dynamic analysis of a rotor blade with lead-lag freedom, flapping freedom, and variable-controlled blade pitch angle basin A multi-site magnetotelluric measurement system p0747 880-30950 with real time data analysis Simulation of the energy-industry-environment system for limited economic regions, using the example of Baden-Buerttemberg. Part 1: Data, THERMO ELECTRON CORP., WALTHAM, MASS.

Rectric energy production by particle
thermionic-thermoelectric power generators model development adaptation [IKB-K-54-20-PT-1] p0589 880-32 SUBTRCH, INC., MARCUS HOOK, PA. Research and development of an advanced process p0589 880-32974 Thermionic converter output as a function of collector temperature for the conversion of coal to synthetic TRANSPORTATION SYSTEMS CENTER, CAMBRIDGE, MASS.
Potential of diesel engine, 1979 summary source gasoline and other distillate fuels Research and development of an advanced process for the conversion of coal to synthetic gasoline and other distillate fuels [FR-2306-35] p0696 880-29514 document [PB80-193659] Potential of diesel engine, emission technology [PB80-192685] p0586 R80-32735 SUBTER RESEABCH ASSOCIATES, CORTE MADERA, CALIF. Engineering design for Thermocrete central storage units for low temperature solar Potential of spark ignition engine, effect of vehicle design variables on top speed, performance, and fuel economy [PB80-191836] p0586 application application
[DOB/CS-34702/4] p0638 N80-29883
SWEDISH COUNCIL FOR BUILDING RESEARCH, STOCKHOLM.
Beporting format for thermal performance of solar heating and cooling systems in buildings
[PR80-175375] p0634 N80-29537
SYSTEMS SCIENCE AND SOFTWARE, SAN DIEGO, CALIF.
Organic material emissions from holding ponds at TRAVIS-BRAUH AND ASSOCIATES, IRC., DALLAS, TEX.
Solar heating and hot water system installed at
office building, One Solar Place, Dallas, Texas
[HASA-CE-161483]
p0634 H80-29846 TRU BURRGY SYSTEMS, BEDOUDD BRACE, CALIF.

Peasibility study for industrial cogeneration
fuel cell application coal-fired power generation facilities [BPRI-EA-1377] p0589 [SAN-1889-T1] p0589 N80-32987 TRU BEERGY SYSTEMS PLANNING DIV., MCLEAR, VA.

Hethane recovery from coalbeds project, phase 2
[DOB/MC-08089/T4] p0705 880-31645 Underground gasification for steeply dipping coal beds. Rawlins test no. 1 [SAN-13108-35] p0705 N80-TATA BEERGY RESEARCH INST., BOMBAY (INDIA).

Solar passive systems for buildings
[PB80-187719] p0656 880-329

TATA INST. OF FUNDAMENTAL RESEARCH, BORBAY (INDIA).

Solar passive systems for buildings
[NP-24377] p0643 880-309

TECHNICAL DRIV. OF DENHARK, LINGBY. p0656 #80-32962 p0643 B80-30947 URLAND AND JUNEBR, ARCHITECTS AND PLANNERS, PHILADELPHIA, PA.
Solar atrium: A hybrid solar heating and Solar energy applications for dwelling; modelling and simulation part [EUR-6681/I-EN] cooling system [DOE/CS-34135/6] p0645 N80-31894 TECHNISCHE HOGESCHOOL, DELFT (HETHERLANDS). Solar atrium: A hybrid solar heating and Absorption refrigeration machine driven by solar cooling system [ALO-4135-T2] heat UBION CARBIDE CORP., OAK RIDGE, TRNS.
Assumptions and ground rules used in nuclear
waste projections and source term data
[ONNI-24] p0585 880 [ BUR-6748-BN] TECHNISCHE HOGESCHOOL, RINDHOVEN (NETHERLANDS).

A parametric study of 1000 NWe combined closed cycle HHD/system electrical power generating p0585 N80-32203 UNITED AIR LINES, INC., CHICAGO, ILL. Current jet fuel trends [TH-78-E-91] p0742 M80-28931 The dispersion relation of electrothermal waves UNITED TECHNOLOGIES CORP., BAST HARPFORD, COM.

Peasibility study: Fuel cell cogeneration in a
water pollution control facility, volume 1
[DOE/ET-12431/T1-VOL-1] p0749 N80-31922 in a nonequilibrium magnetohydrodynamic plasma P0744 N80-30198 [TH-78-E-92] TENNESSE VALLEY AUTHORITY, CHATTANOOGA.
Seasonal thermal energy storage
[PNI-3322] p0 p0778 #80-32899 UTRC 8 kW wind turbine tests TERRA TEK, IBC., SALT LAKE CITY, UTAH.
Seasonal thermal energy storage
[PNL-3322] [RPP-3085] ONITED TRCHNOLOGIES CORP., SOUTH WINDSOR, COM... Cogeneration Technology Alternatives Study (CTAS). Volume 3: Energy conversion system p0778 N80-32899 TEXAS A6H UNIV., COLLEGE STATION.

Research and development for inertial energy storage based on a flexible flywheel [SAND-79-7097] p0778 880characteristics [MASA-CR-159761] p0748 M80-31869 AC/DC power converter for batteries and fuel cells [EPRI-EM-1286] p0750 M80-31937 [ NASA-CR-159761 ] p0778 N80-32898 Seasonal thermal energy storage [PNL-3322] p0778 N80-32899 Development of molten carbonate fuel cell power Changes in the potential for wind energy generation due to terrain modification of the boundary-layer flow plant technology [DOE/ET-15440/1] Advanced technology fuel cell program [EPRI-EH-1328] p0752 N80-326 Coal gasification combined-cycle system analysis p0714 N80-34020 TEXAS INSTRUMENTS, INC., DALLAS.
Spectral effects on direct-insolation
absorptance of five collector coatings
[ASHE PAPER 79-81-18] p0597 [ BPBI-AP-1390 ]

p0597 A80-45722

```
3. 1
                                                                                                                       WASHINGTON QUIV., SEATTLE.
Photocell heat engine solar power systems
                                                                                                                                                                                                ٠.
UNITED TECHNOLOGIES RESEARCH CENTER, BAST HARTFORD,
       CONN.
                                                                                                                              p0612 A80-48179
A new method of efficient heat transfer and storage at very high temperatures
            Autoignition characteristics of aircraft-type
                fuels
                [ NASA-CR-159886]
                                                                              p0698 N80-30535
            Development of an 8 kW wind turbine generator for residential type application. Phase 1:

Design and analysis. Volume 1: Executive
                                                                                                                         WAINE STATE UNIV., DETROIT, MICH.
Ultrasonic characterization of coal liquefaction
                 sunnary
                                                                                                                                  products
      [DOE/DP-03533/T1-VOL-1] p0753 H80-32:
UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES.
Low cost solar cells based on amorphous silicon
                                                                                                                              [DDR/PC-10346/1] p0702 880-3
Basic Research in Engineering: Process and
Systems Dynamics and Control. High Priority
                                                                               p0753 #80-32957
                                                                                                                                                                                                p0702 N80-31503
                electrodeposited from organic solvents
                                                                                                                                  Research Needs Relevant to Energy
            electrodeposited from organic solvents
[SAB-0113-040-T7] p0637 B80-298*
Low cost solar cells based on amorphous silicon
electrodeposited from organic solvents
[SAB-0113-040-T6] p0648 B80-319*
P. INC., DES PLAINES, ILL.
Upgrading of coal liquids: Hydrocracking of EDS
process derived gas oils
[FR-2566-31]
                                                                               p0637 880-29873
                                                                                                                                  [PE-2468-65]
                                                                                                                                                                                                 p0590 #80-33167
                                                                                                                        WESTHEROUSE RIECTRIC CORP., EAST PITTSBURGH, PA.
Design study and economic assessment of
multi-unit offshore wind energy conversion
systems application. Volume 1: Executive
                                                                               p0648 N80-31953
                                                                                                                         SUBBALY
[WASH-2330-78/4-VOL-1] p0746 H80-30930
BESTINGHOUSE ELECTRIC CORP., MADISON, PA.
Advanced coal gasification system for electric
                 [PB-2566-33]
                                                                               p0699 B80-30545
      UTAH UHIV., SALT LAKE CITY.
            Applied research and evaluation of process concepts for liguefaction and gasification of
                                                                                                                                  power generation
[FB-1514-97]
                                                                                                                                                                                                 p0700 N80-30548
                 western coals
                                                                                                                               Advanced coal gasification system for electric
                                                                                                                        Advanced coal gasification system for electric power generation
[PE-1514-101] p0703 N80-31634
Advanced coal gasification system for electric power generation
[PE-1514-113] p0709 N80-32557
WESTINGHOUSE RIRCTRIC CORP., PITTSBURGH, PA.
Second phase of a coalbed methane extraction and utilization program
[AESD-TME-3026] p0700 N80-30556
HHD electrode development
                [FE-2006-16]
                                                                               p0691 H80-28558
            Applied research and evaluation of process concepts for liquefaction and gasification of
    western coals
[PE-2006-17] p0700 H80-30
UTAH WATER RESEARCH LAB., LOGAN.
Design of a cost effective solar powered water
                                                                               p0700 N80-30549
                pump
[PB80-182819]
                                                                               p0649 N80-31967
                                                                                                                              [RESU-TRE-3026]

HHD electrode development
[FE-15529-5]

Collector sealants and breathing
[DDE/CS-15362/1]
                                                                                                                                                                                                 p0748 #80-31222
      VARIFLEX CORP., WASHINGTOB, D.C.
Worldwide transportation/energy demand,
1975-2000: Revised Variflex Bodel projections
[ORML/SUB-79/45740/1] p0578 N80-28915
VARIGAS RESEABCE, INC., THORNUB, DD.
Comparative study of the energy characteristics
of powered hand tools. Part 2: Investigation
                                                                                                                                                                                                 p0650 N80-32527
                                                                                                                              Open-cycle MBD systems analysis
[EPRI-AP-1316]
                                                                                                                                                                                                 p0753 #80-32881
                                                                                                                         DESTINGUOUSE RESEARCH AND DEVELOPMENT CENTER,
                                                                                                                         PITTSBURGE, PA.
Silicon web process development
[NASA-CE-163386]
                                                                                                                                                                                                 p0631 N80-28864
                                                                                                                         Cell module and fuel conditioner [NASA-CR-159888] WISCORSIN ONIV. - MADISON.
                reports
      [SAN-1731-T2] p0577 #80-28856
VIRGINIA POLYTECHNIC INST. AND STATE UNIV.,
BLACKSBURG
                                                                                                                                                                                                 D0749 N80-31882
      BLACKSBURG.
                                                                                                                              Plywheel energy management systems for improving
            the fuel economy of motor vehicles [PB80-175300] p
WOBCESTER POLYTECHNIC INST., MASS.
                                                                                                                                                                                                p0777 N80-31278
                collectors. Appendix 1: Data listing for top
and bottom of collector
[PB80-158751] p0633 880-28
                                                                                                                              Rinetics and mechanisms of catalytic hydroliquefaction and hydrogasification of
                                                                               p0633 880-28937
                                                                                                                                  lianite
            Development and application of analytical
                                                                                                                                  [PB-2702-8]
                                                                                                                              Kinetics and mechanisms of catalytic hydroliquefaction and hydrogasification of
                techniques to chemistry of donor solvent
            liquefaction
[PE-2696-T4]
Performance of a diesel engine operating on raw
coal-diesel fuel and solvent refined
coal-diesel fuel slurries
                                                                              p0695 N80-29472
                                                                                                                                  lianite
                                                                                                                                  [FE-2702-10]
                                                                                                                                                                                                p0709 N80-32556.
                                                                                                                        MORBSER SCIENTIFIC CORP., STAMPORD, CONN.
Installation, operation, and maintenance for the
pyramidal optics solar system installed at
            coal-diesel ruel sturries
[COBS-3288-76] p0701 N80-30758

CdSiAs2 thin films for solar cell applications
[DOS/ET-23007/1] p0653 N80-32919

Development and application of analytical
techniques to chemistry of donor solvent
                                                                                                                              Yacht Cover, Columbia, South Carolina
[NASA-CR-161203] p0657 N80-33864
Design data brochure for a pyramidal optical
                                                                                                                                 solar system
[NASA-CR-161202]
                liquefaction [DOB/PC-20041/T1]
                                                                                                                                                                                                D0657 N80-33865
                                                                                                                        WYOMING UNIV., LARANIE.

New method to determine the independent shear
      [DÔE/PC-20041/T1] p0712 880-33520
VONIER (THOMAS) ASSOCIATES, IMC., WASHINGTON, D.C.
         . Capital formation for small wind energy
                                                                                                                                 moduli of transversely isotropic materials [CONF-800575-1] p0712 N80
                                                                                                                                                                                                p0712 N80-32796
                conversion system manufacturers: A guide to methods and sources
                [SERI/TR-98298-1]
                                                                               p0751 N80-32462
  WAIKATO UBIY., HAMILTON (NEW ZBALAND).

The potential of energy farming for transport fuels in New Zealand
[PB80-154248] p0693 880-
            [PB80-154248] p0693 880-28572
The potential of energy farming for transfort
```

The potential of energy farming for transport fuels in New Zealand, appendices [PB80-159255] p0693 N80-28 WASHINGTON STATE UNIV., PULLHAM.

Comparison of coal-fired power systems in waste heat applications in Tacoma, Washington [TID-29379] p0693 N80-28

p0693 N80-28573

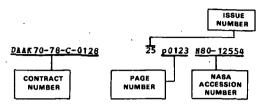
p0693 N80-28858

# CONTRACT NUMBER INDEX

ENERGY / A Continuing Bibliography (Issue 28)

JANUARY 1981

#### Typical Contract Number Index Listing



Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the IAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in either the IAA or STAR section. Preceding the accession number are the issue and page number in the particular supplement in which the citation may be found.

AF PROJ. 2308
p0754 N80-33228
AP PROJ. 3145
p0743 180-29738
p0751 N80-32226 p0780 N80-33908
AP PROJ. 3260
p0666 N80-31651
AP PROJ. 9000
p0703 N80-31630
AF-AFOSE-0083-79
p0754 #80-33228
ARB-A7-075-30
p0585 #80-31982
p0585 N80-31983
ARGC-B75/15538
p0737 A80-50356
BMPT-BT-4045
p0603 A80-46725
p0606 A80-46770
P0608 A80-46789
BMPT-BT-4190-A
p0604 A80-46741
BMPT-NT-0845 p0600 A80-46698
p0600 A80-46698 BMPT-NT-0846
p0600 A80-46698
CEC-107-76-ESF
p0602 A80-46714
CEC-153-77-9-ESB
p0601 A80-46706
CEC-206-76-ESF
p0603 A80-46731
CEC-315-78-REDK
p0605 A80-46747
CEC-316-78-EEUK
p0605 A80-46747
CEC-428-78-BSD
p0606 A80-46770
CBC-442-78-2-BSN
p0600 A80-46696
CEC-474-78-4 p0609 A80-46794
DA PROJ. 4A7-61102-AT-23
p0636 N80-29864
DA-BRO-78-G-0039
p0772 A80-48770
DAAB07-77-C-0458
p0737 A80-50509
DAAB07-77-C-0472
p0737 A80-50507
DAAB07-78-C-0535
p0737 A80-50509
DAAB07-78-C-0564

p0774 A80-51688

```
DAAG53-75-C-0269
 p0777 N80-31892
 DAAK70-78-C-0103

p0745 N80-30905

DAAK70-79-C-0048

p0699 N80-30538

DE-AC01-76RT-10161
 p0709 880-32557
DB-AC01-77RT-10622
 p0710 N80-32572
DB-AC01-77RT-26931
 p0778 H80-32897
DE-AC01-78BT-12103
 p0710 N80-32569
DB-AC01-79CS-30027
           p0633 N80-28947
           p0649 #80-31975
 DE-AC01-79CS-30032
           p0626 A80-52826
 DE-AC01-79RI-10456
 p0782 N80-32869
DE-AC01-79RI-10547
 p0693 N80-28570
DE-AC01-79RB-10041
 p0639 N80-29897
DB-AC01-79RT-10554
           p0679 A80-49630
 DB-AC01-79ET-10815
 p0722 A80-48040
DE-AC01-79RT-11268
p0707 N80-32272
DB-AC01-79R1-14102
           p0710 N80-32567
 DE-AC01-79BT-14809
           p0702 #80-31502
 DE-AC01-79RT-14851
           p0706 N80-31659
 DB-AC01-79ET-14876
 p0691 B80-28556
DE-AC01-79ET-14941
           p0701 H80-30557
 DB-AC01-79B1-15440
 p0750 880-31938
DE-AC01-79ET-15529
 p0748 N80-31222
DB-AC01-79RT-26707
 p0771 A80-48478
DB-AC01-79PB-70048
           p0713 H80-33602
 DE-AC01-79PE-70078
 p0749 N80-31885
DB-AC01-80RT-15602
 p0724 A80-48224
DE-AC02-76CE-00016
           p0638 N80-29881
```

```
p0642 #80-30919
         P0582 N80-30936
                 N80-31928
         D0647
                 N80-31933
         p0647
         p0667
                 N80-32559
         p0710
                 ¥80-32570
         p0585 #80-32731
         D0760 N80-32789
                 #80-32900
         p0587
                 N80-32901
         p0588 N80-32972
         p0667 #80-33205
DB-AC02-76CH-00178
p0587 N80-32888
DE-AC02-76CH-03073
         p0717 A80-43973
p0735 A80-48765
DE-AC02-76 RT-11283
p0730 A80-48422
DE-AC02-76ET-11291
p0730 A80-48423
DE-AC02-76BT-11292
p0732 A80-48473
DE-AC02-76ET-11293
p0732 A80-48474
DE-AC02-76ET-20279
         p0587 N80-32874
         p0653 N80-32914
DB-AC02-77CH-00178
         p0645 N80-31904
         p0588 N80-32911
         p0654 H80-32934
         P0655 N80-32946
P0655 N80-32947
         p0779 #80-32948
         p0779 N80-32949
p0779 N80-32955
         p0753 N80-32956
                 N80-32959
DR-AC02-77CS-34484
p0656 #80-32952
DE-AC02-77ET-20050
         p0708 N80-32545
DB-AC02-78CS-34702
p0638 N80-29883
DB-AC02-78ET-5103-A002
         p0736 A80-49075
DE-AC02-78BT-20090
p0654 H80-32929
DB-AC02-78ET-20611
p0700 880-30552
DE-AC02-79CS-30242
p0649 880-31955
DB-AC02-7987-1400
p0676 A80-48380
DE-AC02-79ET-15207
p0752 #80-32723
DB-AC02-79ET-15209
p0744 #80-30755
DE-AC02-79ET-23004
p0642 H80-30912
DE-AC02-80ET-26225
p0666 #80-31651
DE-AC03-77ET-11319
         p0721 180-47135
         p0721 180-47136
p0726 A80-48279
DE-AC03-78ET-11276
p0750 880-31935
DB-AC03-78ET-12431
p0749 N80-31922
DB-AC03-78ET-20419
p0652 880-32892
DE-AC03-78ET-20567
p0645 880-31896
         p0645 880-31897
          P0648 N80-31948
DB-AC03-78RT-21050
         p0586 880-32867
         p0586 #80-32868
DE-ACO3
          -78BT-21074
         p0653 N80-32921
```

DE-AC03-79CS-30308 p0633 N80-29505
DE-AC03-79ET-23044
p0653 N80-32920
DE-AC03-89ET-23047 p0597 A80-46258 DE-AC04-76CS-53682 p0708 880-32552 DE-AC04-76DF-00053 p0617 A80-48363 p0702 H80-31506 DB-AC04-76DP-00789 p0717 A80-43972 p0761 A80-45725 p0676 A80-48345 p0735 A80-49067 p0735 A80-49068 P0623 A80-50800 DO741 N80-28756 p0631 N80-28876 p0706 880-31655 D0646 N80-31918 p0647 N80-31924 p0648 N80-31949 n0584 N80-31950 D0649 N80-31954 p0709 N80-32560 p0650 N80-32790 D0586 N80-32870 p0651 N80-32885 p0651 N80-32887 p0652 #80-32889 p0652 N80-32890 p0652 N80-32891 p0652 #80-32894 D0652 N80-32895 D0778 N80-32898 p0654 N80-32935 D0654 H80-32936 D0655 N80-32937 p0655 B80-32938 D0656 N80-32953 p0659 N80-33911 p0715 N80-34239 DE-AC04-76DP-03533 p0726 A80-48270 p0742 N80-28925 p0742 N80-28926 p0746 880-30907 p0746 N80-30908 p0746 N80-30931 p0752 N80-32722 p0753 N80-32950 p0753 N80-32957 DE-AC04-78CS-04239 p0655 #80-32944 DE-AC04-78CS-15362 p0650 N80-32527 DR-AC04-78CS-34196 p0647 H80-31921 DE-AC04-79ET-23005 p0632 N80-28895 DE-AC04-79ET-23006 p0653 N80-32915 DE-AC04-79ET-23007 p0653 N80-32919 DB-AC04-79ET-23013 p0642 N80-30921 DE-AC05-760R-00033 p0584 N80-31939 p0589 N80-32983 DB-AC05-77CS-05262 p0577 880-28857 DE-AC05-77CS0-5438 p0680 A80-49711 DB-AC05-77BT-20170 p0631 N80-28880 DB-AC05-7918-53044 p0718 A80-44390 DB-AC06-70RL-01830 p0778 #80-32899

#### CONTRACT BUMBER INDEX

DB 1406 7607 04030			
DE-ACO6-76PL-01830 p0585 N80-32203	DB-FG02-79ER-10541 p0656 #80-32953	EC-77-C-02-4146	BG-77-C-04-4159
DE-AC06-76RL-01830	DEN3-28	p0753 N80-32878 EC-77-C-03-1212	p0645 880-31903 BG-77-G-04-4135
p0618 A80-48462	p0736 A80-49724	p0665 N80-30756	p0633 N80-28928
p0618 A80-48463	DBN3-30	EC-77-C-03-1693	p0639 N80-29899
p0747 N80-30941	p0748 N80-31869	p0579 N80-29838	EG-77-S-02-4238
P0777 N80-32873	DEN3-31	EC-77-S-05-5598	p0750 180-31945
p0712 N80-33072	p0741 N80-28859	p0667 N80-32922	EG-77-S-02-4380
p0754 N80-33073	p0745 N8G-30888	BE-77-S-05-5516	p0632 N80-28905
DE-AC06-77ET-20242	p0745 N80-30889	p0693 N80-28858	EG-77-S-02-4459
p0647 N80-31930 DE-AC07-76ID-01570	p0745 N80-30890 p0749 N80-31870	BBC-456-78-1-BSI	p0742 N80-28913
p0725 A80-48267	p0745 B80-31676	p0606 A80-46767 BF-76-C-01-2514	EG-77-S-02-4520 p0632 N80-28902
p0698 N80-29869	p0591 N80-33860	p0691 N80-28554	BG-77-S-05-5362
p0711 N80-32699	p0591 N80-33861	EF-77-A-01-2674	p0631 N80-28880
DE-AC07-79ID-12050	DEN3-38	p0743 N80-29862	EG-77-S-4523-A000
p0723 A80-48183	p0775 N80-29857	EF-77-C-01-1514	p0597 A80-45728
DE-AC08-79DP-40039	DEN3-51	p0700 N80-30548	EI-78-S-01-3297
·p0754 N80-33247	p0717 A80-44107	p0703 N80-31634	p0690 N80-28482
DE-AC20-76LC-10157 p0671 A80-48039	DBN3-52 p0717 180-44106	p0709 N80-32557 BF-77-C-01-2434	EM-78-C-01-5159 p0766 A80-48330
DE-AC21-78MC-08089	DEN3-96	p0703 M80-31630	EM-78-C-02-4977
p0705 N80-31645	P0764 A80-48240	EP-77-C-01-2468	p0753 N80-32942
DE-AC21-78MC-08332	p0775 N80-28866	p0669 A80-45513	EB-78-C-03-1725
p0700 N80-30556	DBN3-100	p0691 N80-28551	p0625 A80-52075
DB-AC21-78EC-08484	P0717 A80-44104	p0705 N80-31644	-EM-78-C-03-2184
p0703 N80-31633	DBN3-116	p0590 N80-33167	p0665 N80-31271
DE-AC22-76ET-10135	р0777 N80-32299 DEN3-124	EP-77-C-01-2566	EM-78-C-04-4196
p0678 A80-48431 DE-AC22-77ET-10634	p0584 N80-31796	p0699 N80-30545	p0647 N80-31921
p0691 N80-28552	DEN3-134	EP-77-C-01-2614 p0753 N80-32943	EM-78-C-04-4272 p0578 N80-28888
DE-AC22-79ET-14800	p0755 N80-33862	BF-77-C-03-1429	E6-78-C-04-4275
p0676 A80-48381	DEN3-161	p0700 N80-30554	p0636 N80-29871
DE-AC22-79BT-14858	p0749 N80-31882	p0703 N80-31631	EM-78-C-04-5305
p0692 N80-28566	DBN3-190	EF-77-G-01-2696	p0636 N80-29870
DE-AC22-79PC-10346	p0763 A80-48194	p0695 N80-29472	BH-78-C-04-5366
p0702 N80-31503	DEN3-00019 p0720 A80-45375	EF-77-S-01-2666	p0612 A80-48038
DB-AC22-80PC-20041 p0712 N80-33520	DI-AA550-CT7-29	p0669 A80-45322 . p0706 N80-31656	PM-78-F-01-5190 P0644 N80-31878
DE-AC22-80PC-30014	p0582 N80-31026	EF-77-S-01-2702	EM-78-F-01-5193
p0758 N80-29473	p0583 N80-31027	p0691 N80-28555	p0635 N80-29848
DE-A101-76ET-12548	DI-14-34-0001-8047	BF-77-S-01-2729	EM-78-F-01-5199
p0714 N80-34093	p0649 N80-31967	p0699 N80-30541	p0657 N80-33858
DE-A101-79ET-20305	DOB TASK III	EF-77-S-01-2762	EN-78-F-01-5204
p0755 N80-33862	p0718 A80-44390	p0577 N80-28557	p0634 N80-29847
DE-A101-79BT-20307 p0636 N80-29858	DOE-07-6953 p0604 A80-46740	EG-77-A-01-4084	EM-78-I-01-4209
DE-A101-79ET-23139	DOE-07-7274	p0635 N80-29849 RG-77-A-01-4093	p0776 N80-31270 p0583 N80-31272
p0752 N80-32858	p0608 A80-46793	p0634 N80-29846	p0748 N80-31273
DE-A 101-79ET-29372	DOE-31-109-38-4141	EG-77-C-01-2522	p0583 N80-31274
p0760 N80-31268	p0766 A80-48327	p0632 N80-28889 .	p0583 N80-31275
DE-A103-79ET-11272	DOE-31-109-38-4205	EG-77-C-01-4042	EM-78-S-01-5235
p0749 N80-31882	p0761 A80-47137	p0595 A80-45311	p0653 N80-32913
DE-AM02-79CH-10012	DOE-31-109-38-4449	p0596 A80-45504	EO-A01-78-3605
p0764 A80-48235 p0764 A80-48236	p0662 A80-48414 DOT-0S-60177	p0630 N80-28565 p0630 N80-28569	p0633 N80-28936 p0633 N80-28937
DE-AM03-76SF-00010-PA-26	p0777 N80-31278	p0694 N80-28892	EP-78-C-03-2057
p0718 A80-44390	DOT-RC-82003	p0632 N80-28893	p0695 N80-29506
DE-AS01-77ET-10618	p0584 M80-31968	p0632 N80-28894	EPA-IAP-D7-0794
p0709 #80-32556	DOT-RC-82011	p0742 N80-28910	p0585 N80-31984
DE-AS01-78ET-10741	p0698 N80-30470	p0637 N80-29872	EPA-R-804740
p0708 N80-32472 DE-AS02-78ER-04657	p0698 N80-30471 DOT-TSC-1693	p0638 N80-29882 p0744 N80-29891	p0582 N80-30966
p0652 N80-32896	p0773 A80-49729	p0/44 880-29891 p0639 880-29892	EPA-R-804811 p0707 880-31990
DE-AS02-79ER-10456	DEET-78-34-265-00-480-75-01	p0639 N80-29893	EPA-R-804979
p0708 N80-32473	p0774 A80-51690	p0639 N80-29894	p0707 N80-31986
DE-AS04-78CS-35305	B(11-1)-2463	p0639 N80-29895	EPA-68-01-2934
p0636 N80-29870	p0572 A80-48533	p0641 N80-30530	p0581 N80-29928
DE-AS04-79CS-30174-501 p0617 A80-48365	E (49-18) -2006 p0700 N80-30549	p0643 M80-30946 p0705 M80-31648	EPA-68-02-1312 p0712 N80-32999
DE-AS05-78ET-20071	B (49-18) -2305	p0703 N80-31848 p0645 N80-31898	EPA-68-02-1885
p0699 N80-30543	p0697 880-29517	p0645 N80-31899	p0702 N80-30952
DE-AS06-76ET-20355	E (49-18) -2434	p0646 N80-31911	EPA-68-02-2136
p0753 N80-32951	p0703 N80-31630	p0646 N80-31916	p0744 N80-29922
DB-AT01-79CS-40178	EA-77-A-01-6010	p0646 N80-31917	EPA-68-02-2147
p0590 N80-33288	p0583 N80-31673	p0647 N80-31926	p0589 N80-32995
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p0735 A80-49058	p0775 N80-28866	p0654 N80-32925	p0589 N80-32997
DE-AT03-76SP-70046	EC-77-A-31-1040	p0655 N80-32946	EPRI PROJ. 317-2
P0724 A80-48248	p0751 N80-32719	p0655 N80-32947	p0692 N80-28567
DB-AT03-76SF-71053	EC-77-A-31-1044	p0779 N80-32948	EPRI PROJ. 323-3
p0671 180-48169	p0766 A80~48329	p0779 N80-32949	p0751 N80-32233
DE-AT20-80LC-10224 p0712 N80-32796	p0584 N80-31796 p0777 N80-32299	p0779 N80-32955	EPRI PROJ. 361-2
DE-A101-79ET-27025	BC-77-A-31-1062	p0753 N80-32956 p0656 N80-32959	p0699 N80-30547 EPRI PROJ. 408-1
p0783 N80-33919	p0748 H80-31869	EG-77-C-02-4484	p0696 N80-29508
DB-PG01-77ET-10660	p0754 H80-33221	р0656 №80-32952	EPRI PROJ. 408-2
p0702 N80-31499	EC-77-C-01-5085	BG-77-C-03-1576	p0696 N80-29508
	p0780 N80-33909	p0603 A80-46726	I

#### COSTRACT NUMBER INDEX

		•	
EPRI PROJ. 640-1	p0707 H80-31912	BY-76-C-03-1101	JPL-955194
p0753 N80-32881	EX-76-A-29-1012	P0648 N80-31943	p0630 N80-28863
EPRI PROJ. 841-1	p0650 N80-32852	p0648 N80-31944	JPL-955271
p0750 880-31937	BX-76-A-29-1020	E I-76-C-03-1167	p0667 N80-32854
EPRI PROJ. 986-2	p0646 N80-31920	p0666 N80-31650	JPL-955279
p0713 N80-33601	EX-76-A-36-1008	BY-76-C-03-1207	p0644 N80-31875
EPRI PROJ. 1348-1	p0783 N80-33919	p0744_N80-30757	JPL-955367
p0751 N80-31960	BX-76-C-01-0496	EY-76-C-04-0789	p0644 N80-31877
ER-78-S-02-4657	p0676 A80-48381	p0692 N80-28562	JPL-955421
p0598 A80-46452	EX-76-C-01-1800 '	p0741 H80-28756	p0666 N80-31624
BB-78-S-02-4947	p0704 N80-31641	p0693 N80-28874	JPL-955447
P0708 N80-32473	BX-76-C-01-1806	p0631 N80-28876	p0758 A80-48506
ER-78-02-4737	p0693 N80-28726	p0775 N80-28878	JPL-955492
p0661 A80-45298	p0701 N80-30753	p0633 N80-28908	p0665 N80-28865
ESA-3787/78-P-FC (SC)	p0712 N80-32728	p0633 N80-28912	JPL-955614
p0640 N80-30348	p0752 N80-32729	P0775 N80-28924	P0650 N80-32855
ESA-3788/78-F-FC (SC)	EX-76-C-01-2006	p0637 N80-29876	JPL-955679
P0640 N80-30349	p0691 N80-28558	p0639 N80-29889	p0777 N80-32856
BT-75-I-01-9036	p0700 N80-30549	p0642 N80-30911	MBI-2392/100
p0586 N80-32827	EX-76-C-01-2044	p0582 N80-30923	p0681 A80-49948
ET-77-C-01-2621	p0699 N80-30540	p0776 N80-30924	NAG3-16
P0711 N80-32726	EX-76-C-01-2211	p0746 N80-30933	p0762 A80-48180
ET-77-C-01-8917	p0704 N80-31642	p0648 N80-31942	NASW-2936
p0743 N80-29741	EX-76-C-01-2286	p0750 N80-31958	p0649 N80-31963
ET-78-C-01-2595	p0678 A80-48432	EY-76-C-04-3533	NASW-3198
p0691 N80-28553	EX-76-C-01-2305	p0746 N80-30907	P0749 N80-31881
p0710 N80-32569	p0697 N80-29517	p0746 N80-30908	NAS1-15239
ET-78-C-01-2785	p0710 N80-32568	p0747 N80-30943	p0708 N80-32533
p0704 N80-31640	EX-76-C-01-2306	EY-76-C-06-1830	NAS2-8300
ET-78-C-01-2806	p0696 N80-29513	p0642 N80-30920	p0614 A80-48212
p0686 A80-51210	p0696 N80-29514	p0747 N80-30941	NAS2-10079
p0704 N80-31637	BX-76-C-01-2315	p0643 N80-31435	p0612 A80-48179
ET-78-C-01-3044	p0691 N80-28550	EY-76-C-06-2443	NAS3-20066
p0690 N80-28548	p0699 N80-30544	p0647 N80-31930	p0698 N80-30535
p0704 N80-31635	p0703 N80-31629	BY-76-C-07-1570	NAS3-21251
ET-78-C-01-3105	EX-76-C-01-2330	p0698 N80-29869	p0630 N80-28860
p0692 N80-28563	p0746 N80-30930	EY-76-F-06-2227	NAS3-21757
ET-78-C-01-3125 p0674 A80-48292	BX-76-C-01-2341 p0722 A80-47763	p0694 N80-28996 EY-76-S-02-2588-A002	p0758 A80-48357
p0704 N80-31638	BX-76-C-01-2373	p0621 A80-48922	p0759 N80-29845 NAS3-21926
p0704 N80-31639	p0641 N80-30895	EY-76-S-02-2904	p0617 A80-48356
ET-78-C-01-3137	EX-76-C-01-2384	. p0690 N80-28478	NAS5-24232
p0696 N80-29510	p0650 N80-32851	EY-76-S-03-0034	p0698 N80-29822
BT-78-C-01-3240	EX-76-C-01-2416	p0666 N80-31927	. NAS7-100
p0692 N80-28561	p0690 N80-28542	BY-76-S-03-0113	p0757 A80-45534
p0696 N80-29509	p0690 N80-28543	p0637 N80-29873	p0613 A80-48206
ET-78-C-02-4881	EX-76-C-01-2434	p0648 N80-31953	. p0614 A80-48210
p0745 N80-30902	p0703 N80-31630	EY-76-S-05-5053	p0732 A80-48477
ET-78-C-02-5022	P0704 N80-31636	p0764 180-48237	p0630 N80-28863
p0700 N80-30552	EX-76-C-01-2478	BY-76-5-03-0326	P0665 N80-28865
ET-78-C-03-1889 p0746 N80-30934	p0750 N80-31936	p0622 A80-50510	p0634_N80-29843
ET-78-C-03-2051	p0751 N80-32234 EX-76-C-01-2514	EY-77-C-03-1731 p0577 N80-28856	p0636 N80-29858
p0586 N80-32867	p0676 A80-48380	EY-77-C-05-5262	p0636 N80-29859 p0760 N80-31268
p0586 N80-32868	EX-76-C-06-2332	p0577 N80-28857	p0666 N80-31624
p0587 N80-32893	p0580 180-29840	EY-77-S-06-2438	p0586 N80-32827
ET-78-C-03-2207	EX-76-C-10-3876	p0706 N80-31900	p0650 N80-32850
p0638 N80-29879	p0579 N80-29516	p0706 N80-31901	p0650 N80-32852
ET-78-C-03-2219	EX-77-C-01-2518	P04701-74-C-0450	p0667 N80-32854
p0602 A80-46722	p0674 A80-48292	p0769 A80-48400	p0777 N80-32856
ET-78-C-03-2240	EY-76-C-02-0016	F04704-77-C-0014	p0714 N80-34093
p0630 A80-53572	p0679 A80-49626	p0772 A80-48489	NAS8-32036
ET-78-C-04-4270	p0664 A80-51460	F33615-77-C-2004	p0635 N80-29850
p0656 N80-32954	p0692 N80-28560	p0765 A80-48272	p0635 N80-29851
ET-78-C-04-4281	p0742 N80-28920	₽33615-78-C-2058 .	p0635 N80-29853
p0633 N80-28909	p0636 N80-29867	p0780 N80-33908	p0635 N80-29854
ET-78-C-06-1095	p0638 N80-29881	P33615-78-C-2074	p0635 N80-29855
p0663 A80-48451	p0744 N80-29885	p0713 N80-33599	p0635 N80-29856
BT-78-G-01-3281	p0638 N80-29888	GA PROJ. 3315	p0641 N80-30893
p0576 A80-51202	p0642 N80-30919	p0633 N80-29505	p0641 N80-30894
ET-78-I-01-2895	p0642 N80-30926	HOD-H-2372	p0641 N80-30896
p0751 N80-32231	p0747 N80-30937	p0646 N80-31920.	p0644 N80-31872
ET-78-S-01-3177 p0708 N80-32472	p0647 N80-31933	JNICT-131,79,108	p0644 N80-31880
ET-78-S-01-3274	p0666 N80-32553 p0587 N80-32883	p0625 A80-51685 JPL PROJ. 2369	p0645 N80-31883 NAS8-32093
p0759 N80-29629	EY-76-C-02-2749	p0644 N80-31877	p0630 N80-28861
ET-78-S-01-3288	p0751 N80-32719	JPL-954376	NAS8-32245
p0701 N80-30758	RY-76-C-02-2858	p0601 A80-46704	p0657 N80-33866
ET-78-S-01-3297	p0647 N80-31941	JPL-954563	p0657 N80-33867
p0690 N80-28545	BY-76-C-02-3073	p0598 A80-46452	NAS8-32250
p0690 N80-28546	P0719 A80-44663	JPL-954654	p0657 N80-33864
ET-78-S-02-5085	P0719 A80-44664	p0631 N80-28864	p0657 N80-33865
p0584 N80-31915 :	p0733 A80-48495	JPL-954739	NAS8-32475
ET-78-S-05-5912	p0735 A80-49071	p0651 N80-32857	p0759 N80-30900
p0699 N80-30543	p0736 A80-49072	JPL-954883	p0759 880-30901
ET-78-X-01-3992	BY-76-C-02-4094	p0644 N80-31876	p0760 N80÷31890
p0705 N80-31647	p0746 N80-30928	JPL-955009	p0651 N80-32859
ET-78-5-03-1840 p0675 A80-48341	p0646 N80-31913 BY-76-C-03-0115	p0729 A80-48387 p0732 A80-48476	p0651 N80-32860 p0651 N80-32861
EW-78-A-21-8450	p0752 N80-32865	JPL-955033	NAS8-32981
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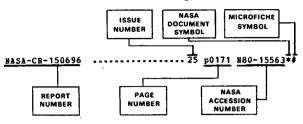
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          p0759 N80-30891
                                                    p0678 A80-48516
MAS8-33511
                                                    p0631 N80-28875
p0614 A80-48207
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                                                     p0578 #80-28915
p0641 H80-30898
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p0650 N80-32853
                                                    p0582 N80-30938
                                                    p0748 N80-31253
p0583 N80-31632
p0605 A80-46752
NG8305-76-C-0036
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p0597 A80-45728
NR PROJ. 036-108
                                                    p0585 N80-32203
p0707 N80-32278
p0651 N80-32857
NRC OSX-78-00062
                                                    p0666 #80-32554
                                                    p0709 N80-32562
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NSF ENG-76-12250
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                                                    p0586 N80-32871
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                                                    pQ587 N80-32880
                                                    p0587 N80-32904
                                                    p0588 880-32958
p0689 180-54063
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p0759 N80-30656
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WSG-1425
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p0613 A80-48204
                                                    p0711 N80-32573
                                                    p0588 N80-32973
p0726 A80-48284
                                                    p0754 N80-33233
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p0597 180-45722
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p0613 A80-48198
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p0726 A80-48284
p0675 A80-48340
p0770 A80-48401
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p0598 A80-46386
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p0775 N80-28884
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p0701 N80-30904
N00140-78-C-1491
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P0640 N80-29904
p0694 H80-29306
OWEC-10773210
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         p0578 N80-28958
                                                    p0582 N80-30942
p0579 N80-28960
PROJ. 61021
                                                    p0643 N80-31538
p0703 N80-31628
         p0750 N80-31935
                                                    p0705 N80-31646
RE0240145
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p0777 N80-32862
SRI PROJ. PYU-7930
                                                    p0705 N80-31654
                                                    p0760 N80-31923
         p0692 N80-28561
p0696 N80-29509
                                                    p0647 N80-31932
                                                    p0709 N80-32564
                                                    p0709 N80-32565
SWEDBESD-5061-012
         p0741 N80-28732
p0742 N80-28932
                                                    p0710 N80-32566
                                                    p0587 N80-32905
                                                    p0778 N80-32907
SWEDBESD-5061-101
p0742 N80-28933
W-31-109-ENG-38
                                                    p0588 N80-32909
                                                    p0653 N80-32916
        p0724 A80-48223
p0625 A80-51678
p0578 N80-28885
                                                    p0654 N80-32926
                                                    p0654 N80-32927
                                                    p0778 N80-32940
                                                    p0779 N80-32941
         p0580 N80-29886
         p0580 H80-29887
                                                    D0754 N80-33237
         p0700 N80-30551
                                           #-7405-ENG-82
         p0701 N80-30558
                                                    p0690 N80-28549
                                           p0702 N80-30929
p0648 N80-31952
W-7405-ENG-92
         P0581 N80-30914
         p0581 N80-30915
         p0582 N80-30916
                                                    p0696 N80-29511
p0584 N80-31940
         p0776 #80-30927
         D0750 N80-31951
         p0707 880-32467
                                                    p0584 N80-31950
         p0708 880-32547
                                           XP-9-8002-5
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505-32 p0755 880-33357
         p0654 N80-32928
H-7405-BNG-26
         P0719 A80-44656
P0569 A80-45481
P0723 A80-48221
         p0674 A80-48295
```

# REPORT/ACCESSION INDEX

#### ENERGY /A Continuing Bibliography (Issue 28)

JANUARY 1981

## Typical Report/Accession Number Index Listing



Listings in this index are arranged alphanumerically by report number. The issue and page number indicate the actual Supplement and page where the citation may be located. The accession number denotes the number by which the citation is identified. An asterisk (\*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

AAS 79-304	p0626	A80-52280*
	•	
AD-A080614	p0780	N80-33906 #
AD-A084555	p0741	N80-28867 #
AD-A084948	p0631	N80-28869 #
AD-A085601	p0743	N80-29738 #
AD-A085815	p0634	N80-29532 #
AD-A086051	p0636	N80-29864 #
AD-A086196	p0581	N80-30903 #
AD-A086506	p0701	N80-30904 #
AD-A086579	p0745	N80-30905 #
AD-A087022	p0751	N80-32226 #
AD-A087053	p0699	N80-30538 #
AD-A087076	p0777	N80-31892 #
AD-A087509	p0645	N80-31895 #
AD-A087753	p0777	N80-32862 #
AD-A088333	p0754	N80-33228 #
AD-A088594	p0780	N80-33908 #
AD-A088660	p0659	N80-33907 #
AD-A089101	p0713	N80-33599 #
	-	
AD-E000413	p0741	N80-28867 #
AD-E000495	p0777	N80-32862 #
AEC-300-80-004	p0593	N80-33973 #
	-	
ABS-UPR-C-481	p0699	N80-30543 #
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AESD-TME-3026	p0700	N80-30556 #
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AFIT-CT-80-19T	p0659	N80-33907 #
APIT-LSSR-66-80	p0645	N80-31895 #
APOSR-80-0599TE	p0754	N80-33228 #
•		
AFWAL-PO-79-036	p0743	N80-29738 #
AFWAL-TR-80-2012	p0713	N80-33599 #
AFWAI-TR-80-2014	p0743	N80-29738 #
APWAL-TR-80-2021	p0751	N80-32226 #
AFWAL-TR-80-2050	p0780	#80-33908
AGAR C-CP-276	p0743	N80-29342 #
AIAA PAPER 80-1341	p0717	A80-44126 #
AIAA 80-1740	p0757	A80-45534*#
ALO-3682-T1	p0708	N80-32552 #
ALO-4135-T2	p0639	N80-29899 #
ALO-4159-1	p0645	N80-31903 #
ALO-4272-T2	p0578	N80-28888 #

, .		
ALO-4281-1	p0633	N80-28909 #
	-	
ANL-80-12		N80-30551 #
ABI-80-32	p0776	N80-30927 #
LUZ CONCH T	- 0530	×00 00005 #
ANL/CNSV-7	p0578	N80-28885 #
ANL/EES/TH-85	p0707 p0708	N80-32467 # N80-32547 #
ABL/EDS/IN-OU	P0100	MOU-32347 #
AR-1	n0708	N80-32548 #
AR-1		N80-32857*#
AR-2	p0665	N80-30756 #
AR-3	p0577	N80-28488 #
AR-3	p0666	
•	-	
ARB-R-79/117 ARB-R-80/116	p0585	N80-31983 #
ARB-R-80/116	p0585	N80-31982 #
ARI-RP-43 ARI-RP-46	p0750	N80-31936 #
ARI-RP-46	pu/51	N80-32234 #
ASE-4524	p0636	N80-29871 #
	poodo	100-290/1
ASME PAPER 78-WA/HT-64	p0686	A80-52049 #
ASME PAPER 79-GT/ISR-2	p0720	A80-45663 #
ASME PAPER 79-HT-18	p0597	A80-45722*#
ACKE DADED 70-UM-25	p0761	A80-45725 #
ASME PAPER 79-LT-36	p0761	A80-45726 #
ASME PAPER 79-LT-36 ASME PAPER 79-LT-67	p0597	A80-45728 #
BOOD FREDE / 9-30L-0	p0596	A80-45662 #
ASME PAPER 80-HT-2		A80-48001 #
ASME PAPER 80-HT-17	p0611	A80-48008 #
ADES PAPER OUTET 10		A80-48009 #
ASHE PAPER 80-HT-21	PU612	A80-48011 #
		A80-48022 # A80-48034 #
		A80-48036 #
ASME PAPER 80-HT-107 ASME PAPER 80-HT-117 ASME PAPER 80-HT-123	p0612	A80-48038 #
ASME PAPER 80-ET-123	p0671	A80-48039 #
ASME PAPER 80-HT-125	p0722	A80-48040 #
ASME PAPER 8G-PET-29	p0720	A80-45275 #
•	=	
ASRL-TR-194-2-PT-10	p0742	N80-28932 #
ATR-79 (7759) -1-VOL-1 ATR-80 (7773-03) -1-VOL-1 ATR-80 (7773-03) -1-VOL-2		N80-31271 #
ATR-80 (7773-03) - 1-401-2		N80-31943 # N80-31944 #
AIR-00(///3-03)-1-V0L-2	P0040	800-31344-
AVSD-0170-80-RR	p0777	N80-31892 #
BLL-RTS-12346	p0712	N80-33576
BLL-RTS-12347	p0712	N80-33575
BLM/YM/ES-80/2	p0582	N80-31026 #
		N80-31027 #
BMFT-PB-T-79-60 BMFT-FB-T-79-70 RMPT-PR-T-70-72	20776	NOV-3000E -
PMFT-FR-T-79-70	p0776 p0640	N80-29905 # N80-29906 #
BMFT-PB-T-79-72	p0640	N80-29907 #
BHFT-FB-T-79-72 BHFT-FB-T-79-74	p0776	N80-29908 #
	,	)
BMI-2031-VOL-3	p0696	N80-29511 #
BHI-2043	p0701	
BNI-26923	p0647	N80-31928 #
BNL-26987	p0587	N80-32883 #
BNL-27331		N80-32789 #
BNL-27383	p0636 p0747	N80-29867 # N80-30937 #
BNL-27452 BNL-27457	p0666	N80-30937 # N80-32553 #
BNL-27603.		N80-32553 #
BNL-27662	p0642	
BNL-27667	p0642	N80-30919 #
BNL-27668	p0647	N80-31933 #
BNL-27669	20638	NA0-29881 A

#### BEPORT/ACCESSION NUMBER INDEX

BBL-27711					
	p0638	N80-29888 # I	CONF-800705-1	p0641	#80-30530 #
BNL-27782			COBF-800719-6		
			CONF-800732-1	20370	N80-32565 #
BBL-27783			CUBI-000/32-1	P0/03	MOV-32303 #
BBL-27792	p0585	B80-32731 ₽	COMP-800802-3	p0588	N80-32911 #
BNL-27802	p0587	80-32901 #	COBP-800804-16	p0652	N80-32895 #
BNL-27891	20667	NA0-33205 #	CONF-800804-18		
BBL-51053					
BNL-51072	p0744	180-29885 # [	CONF-800805-1	p0647	N80-31926 #
B#L-51117	p0692	N80-28560 #	CONF-800805-2	p0652	880-32894 #
	•		COBF-800805-6		
a. 50 40	-0742	W00 33606'A	CONF-800806-7		
CAEC-49	PU/13	#80-33606 #			
CA BC-50	p0714	#80-33920 #	CONF-800806-15	P0778	880-32940 #
CARC-57	p0593	H80-33973 #	CONF-800806-19	p0779	N80-32941 #
CABC-59			CONF-800806-22		
				pu//9	880-32933
CABC-66	p0714	#80-33921 #	CONF-800806-28	p0711	N80-32573 #
CAEC-300-80-003	p0593	N80-33972 #	COBF-7905143	p0643	N80-31435 #
CAEC-300-80-005	50588	H80-32963 #	CONF-7909124-1		
CAEC-300-80-025	-0300	800-32903 V			
CABC-500-80-017	p0714	880-33921 #	COMP-7910126-1	P0701	<b>880-30558 ₽</b>
<u>.</u>	_	l l			
CBBC-80-1203-1	n0702	N80-31503 #	COMS-3288-T6	p0701	N80-30758 #
CBBC-00-1203-1 2	POIGE	B00-31303 F	COMC #200-#1-#01-1	P0101	NOO-31272 A
			COMS-4209-T1-VOL-1	P0203	800-31272
CEL-TR-877	p0634	880-29532 #	COBS-4209-T1-VOL-3	P0776	N80-31270 #
<i>1</i> .			CONS-4209-T1-VOL-4	p0748	N80-31273 #
CERL-SR-E-160	D0636	NAG-29864 #	CONS-4209-T1-VOL-6	D0583	N80-31274 #
~ NAME OF THE STATE OF THE STAT	50000	200-25004 ¥			
			CONS-4209-T1-VOL-8		
CISE-1518	p0649	N80-31962 #	CONS-5085-T2	p0780	N80-33909 <b>#</b>
	-	I		•	
CHC-C8178-PR-017	n0655	N80-32944 #	COO-2749-43-VOL-2	p0751	N80-32719**
	2000		C00-2858-24	00607	NO. 310/14
300+00 T			000-2030-24	20047	NOV 2007
COMP-790499-3			C00-2904-15		
CONF-790631-1	p0701	N80-30922 #	COO-3004-2		
COMP-790631-17	D0742	N80-28913 #	COO-4094-66		
CONF-791009			C00-4094-70		
CUBE 731003	poseu	100-23000 F	CUU-4034-70	P0746	800-30320
CONP-791014-1			COO-4238-14	p0750	N80-31945 #
CONF-791021-3	p0631	N80-28875 #	COO-4380-3	p0632	N80-28905 #
COMF-791022-15			COO-4388-10	D0708	N80-32545 #
			COO-4484-07	20656	N80-32052 4
CONF-791072-32		N80-30550 #	COO-4520-1		
CONF-791102-148	00748	N80-31253 #	COO-4881-12	pQ745	N80-30902 #
CONF-791103-112'			COO-4977/1-VOL-4		
			C00-5085-4	20500	#00-3101E #
CONF-791143-6	, puesu		CUU-3003-4	P0204	B00-21312 #
CONF-791185-3		880-30171 #	1		
CONF-791204-37	p0667	¥80-32559 #	CSIR-CENG-294	P0697	N80-29526 #
CONF-791204-38		B80-32570 #	CSIR-CENG-294	p0713	N80-33579 #
COMP-791216-3		N80-32900 #			
			CSIR-BE-1638	-0355	
CONP-800 106-18			CSIR-RE-1638	PU/55	# 808CC-08M
CONF-800204-9	p0666	N80-32553 #	•		
CONP-800207-3	p0639	N80-29892 #	DPVLR-HITT-78-02	p0714	N80-34117 #
CONF-800324-2		N80-30937 #		-	
CONF-800340-6					
		X80-30925 # I	DOR/RETC-PPS-80/2	n0703	NSO-31627 #
			DOE/BETC-PPS-80/2	p0703	N80-31627 #
CONF-800340-7	p0640	N80-29904 #	DOB/CH-00178/T2	p0654	N80-32934 #
CONF-800340-7	p0640	N80-29904 #	DOE/CH-00178/T2	p0654 p0693	N80-32934 # N80-28571 #
CONF-800352-4	p0640 p0655	880-29904 # 880-32947 #	DOE/CH-00178/T2	p0654 p0693	N80-32934 # N80-28571 #
CONF-800352-4	p0640 p0655 p0651	N80-29904 # N80-32947 # N80-32863 #	DOE/CH-00176/T2	P0654 P0693 P0707	N80-32934 # N80-28571 # N80-31946 #
CONF-800352-4	p0640 p0655 p0651 p0752	N80-29904 # N80-32947 # N80-32863 # N80-32722 #	DOE/CH-00178/T2 DOE/CS-0154 DOE/CS-0161 DOE/CS-0165	p0654 p0693 p0707 p0708	N80-32934 # N80-28571 # N80-31946 # N80-32548 #
CONF-800352-4 CONF-800373-1 CONF-800406-5 CONF-800421-3	p0640 p0655 p0651 p0752 p0639	N80-29904 # N80-32947 # N80-32863 # N80-32722 # N80-29895 #	DOE/CH-00176/T2 DOE/CS-0154 DOE/CS-0161 DOE/CS-0165 DOE/CS-0168	p0654 p0693 p0707 p0708 p0589	N80-32934
CONF-800352-4 CONF-800373-1 CONF-800406-5 CONF-800421-3 CONF-800439-6	p0640 p0655 p0651 p0752 p0639 p0643	N80-29904 # N80-32947 # N80-32947 # N80-32722 # N80-29895 # N80-31538 #	DOB/CH-00178/T2 DOB/CS-0154 DOB/CS-0161 DOB/CS-0165 DOB/CS-0168 DOB/CS-04239/T1	P0654 P0693 P0707 P0708 P0589 P0655	N80-32934
CONF-800352-4 CONF-800373-1 CONF-800406-5 CONF-800421-3 CONF-800439-6	p0640 p0655 p0651 p0752 p0639 p0643	N80-29904 # N80-32947 # N80-32947 # N80-32722 # N80-29895 # N80-31538 #	DOE/CH-00176/T2 DOE/CS-0154 DOE/CS-0161 DOE/CS-0165 DOE/CS-0168	P0654 P0693 P0707 P0708 P0589 P0655	N80-32934
CONF-800352-4 CONF-800373-1 CONF-800406-5 CONF-800421-3 CONF-800439-6 CONF-800439-1	p0640 p0655 p0651 p0752 p0639 p0643 p0656	#80-29904 # #80-32947 # #80-32863 # #80-32722 # #80-29895 # #80-31538 # #80-32953 #	DOE/CH-00178/T2 DOE/CS-0154 DOE/CS-0161 DOE/CS-0165 DOE/CS-0168 DOE/CS-04239/T1 DOE/CS-04270/1	P0654 P0693 P0707 P0708 P0589 P0655 P0656	N80-32934
CONF-800352-4 CONF-800373-1 CONF-800476-5 CONF-800421-3 CONF-800439-6 CONF-800439-11 CONF-800446-2-REV-1	p0640 p0655 p0651 p0752 p0639 p0643 p0656 p0754	880-29904 # 880-32947 # 880-32863 # 880-32722 # 880-29895 # 880-31538 # 880-32953 # 880-33237 #	DOE/CH-00178/T2 DOE/CS-0154 DOE/CS-0161 DOE/CS-0165 DOE/CS-0168 DOE/CS-04270/1 DOE/CS-04270/1 DOE/CS-15362/1	P0654 P0693 P0707 P0708 P0589 P0655 P0656 P0650	N80-32934
CONF-800352-4 CONF-800373-1 CONF-800406-5 CONF-800421-3 CONF-800439-6 CONF-800439-11 CONF-800449-1	P0640 P0655 P0651 P0752 P0639 P0643 P0656 P0754	880-29904 # N80-32947 # N80-32863 # N80-32722 # N80-29895 # N80-31538 # N80-32953 # N80-32953 # N80-29884 # N80-29	DOB/CB-00178/T2 DOB/CS-0154 DOB/CS-0161 DOB/CS-0165 DOB/CS-0168 DOB/CS-04239/T1 DOB/CS-04270/1 DOB/CS-15362/1 DOB/CS-30242/2	P0654 P0693 P0707 P0708 P0589 P0655 P0656 P0650 P0649	880-32934
CONF-800352-4 CONF-800373-1 CONF-800406-5 CONF-800421-3 CONF-800439-6 CONF-800439-11 CONF-800446-2-REV-1 CONF-800449-1 CONF-80045-1-1	P0640 P0655 P0651 P0752 P0639 P0643 P0656 P0754 P0638	#80-29904 # # # # # # # # # # # # # # # # # # #	DOE/CH-00178/T2 DOE/CS-0154 DOE/CS-0165 DOE/CS-0165 DOE/CS-0168 DOE/CS-04239/T1 DOE/CS-04270/1 DOE/CS-15362/1 DOE/CS-30242/2 DOE/CS-30435/6	P0654 P0693 P0707 P0708 P0589 P0655 P0656 P0650 P0649 P0633	880-32934 # 80-28571 # 80-31946 # 880-32548 # 880-32944 # 880-32954 # 880-32527 # 880-32527 # 880-28928 # 880-2892
CONF-800352-4 CONF-800373-1 CONF-800473-1 CONF-800421-3 CONF-800439-6 CONF-800439-11 CONF-800449-1 CONF-800449-1 CONF-800451-1	P0640 P0655 P0651 P0752 P0639 P0643 P0656 P0754 P0638 P0636	#80-29904 # #80-32947 # #80-32863 # #80-32722 # #80-29895 # #80-31538 # #80-32953 # #80-33237 # #80-29864 # #80-29867 # #80-2926 # #	DOE/CH-00178/T2 DOE/CS-0154 DOE/CS-0161 DOE/CS-0165 DOE/CS-0168 DOE/CS-04239/T1 DOE/CS-04270/1 DOE/CS-15362/1 DOE/CS-30242/2 DOE/CS-34135/6 DOE/CS-34196/T1	P0654 P0693 P0707 P0708 P0589 P0655 P0656 P0650 P0649 P0633 P0647	880-32934 # N80-28571 # N80-28571 # N80-32548 # N80-32984 # N80-32954 # N80-32527 # N80-32527 # N80-31955 # N80-31951 # N80-31951 # N80-31921 # PRO-31921 # N80-31921 # N80-31
CONF-800352-4 CONF-800373-1 CONF-800473-1 CONF-800421-3 CONF-800439-6 CONF-800439-11 CONF-800449-1 CONF-800449-1 CONF-800451-1	P0640 P0655 P0651 P0752 P0639 P0643 P0656 P0754 P0638 P0636	#80-29904 # #80-32947 # #80-32863 # #80-32722 # #80-29895 # #80-31538 # #80-32953 # #80-33237 # #80-29864 # #80-29867 # #80-2926 # #	DOE/CH-00178/T2 DOE/CS-0154 DOE/CS-0165 DOE/CS-0165 DOE/CS-0168 DOE/CS-04239/T1 DOE/CS-04270/1 DOE/CS-15362/1 DOE/CS-30242/2 DOE/CS-30435/6	P0654 P0693 P0707 P0708 P0589 P0655 P0656 P0650 P0649 P0633 P0647	880-32934 # N80-28571 # N80-28571 # N80-32548 # N80-32984 # N80-32954 # N80-32527 # N80-32527 # N80-31955 # N80-31951 # N80-31951 # N80-31921 # PRO-31921 # N80-31921 # N80-31
COHF-800352-4 CONF-800373-1 COHF-800406-5 CONF-800421-3 COHF-800439-6 COHF-800439-11 COHF-800449-1 COHF-800449-1 COHF-800451-1 COHF-800481-1 COHF-800481-1 COHF-800481-1	P0640 P0655 P0651 P0752 P0639 P0643 P0656 P0754 P0636 P0636 P0636	#80-29904 # #80-32947 # #80-32863 # #80-32722 # #80-29895 # #80-32953 # #80-32953 # #80-29884 # # #80-29884 # # # # # # # # # # # # # # # # # #	DOE/CH-00178/T2 DOE/CS-0154 DOE/CS-0165 DOE/CS-0165 DOE/CS-04239/T1 DOE/CS-04239/T1 DOE/CS-04270/1 DOE/CS-15362/1 DOE/CS-30242/2 DOE/CS-34196/T1 DOE/CS-34702/4 DOE/CS-34702/4	P0654 P0693 P0707 P0708 P0589 P0655 P0656 P0649 P0649 P0633 P0647 P0638	880-32934 # N80-28571 # N80-31946 # N80-32548 # N80-32988 # N80-32954 # N80-32527 # N80-32527 # N80-31955 # N80-28928 # N80-31921 # N80-29883 # N80-29883 # N80-29883 # N80-29883 # N80-38870 # N80-38
CONF-800352-4 CONF-800373-1 CONF-800406-5 CONF-800421-3 CONF-800439-6 CONF-800439-11 CONF-800446-2-REV-1 CONF-800446-1 CONF-800446-1 CONF-800454-1 CONF-800454-1 CONF-800524-3	P0640 P0655 P0651 P0752 P0639 P0643 P0656 P0754 P0636 P0636 P0636 P0634 P0632	#80-29904 # #80-32947 # #80-32863 # #80-32722 # #80-29895 # #80-32953 # #80-32953 # #80-29884 # #80-29867 # #80-29867 # #80-29867 # #80-29903 # #80-29903 # #80-29903 #	DOE/CH-00178/T2 DOE/CS-0154 DOE/CS-0165 DOE/CS-0165 DOE/CS-04239/T1 DOE/CS-04239/T1 DOE/CS-04270/1 DOE/CS-15362/1 DOE/CS-30242/2 DOE/CS-34196/T1 DOE/CS-34702/4 DOE/CS-34702/4	P0654 P0693 P0707 P0708 P0589 P0655 P0656 P0649 P0649 P0633 P0647 P0638	880-32934 # N80-28571 # N80-31946 # N80-32548 # N80-32988 # N80-32954 # N80-32527 # N80-32527 # N80-31955 # N80-28928 # N80-31921 # N80-29883 # N80-29883 # N80-29883 # N80-29883 # N80-38870 # N80-38
CONF-800352-4 CONF-800373-1 CONF-800473-1 CONF-800421-3 CONF-800439-6 CONF-800439-11 CONF-800449-1 CONF-800449-1 CONF-800451-1 CONF-800481-1 CONF-800524-1 CONF-800524-3 CONF-800526-1	P0640 P0655 P0651 P0752 P0639 P0656 P0754 P0638 P0636 P0634 P0634 P0698	#80-29904 # # # # # # # # # # # # # # # # # # #	DOE/CH-00178/T2 DOE/CS-0154 DOE/CS-0165 DOE/CS-0165 DOE/CS-0168 DOE/CS-04239/T1 DOE/CS-04270/1 DOE/CS-15362/1 DOE/CS-30242/2 DOE/CS-34135/6 DOE/CS-34196/T1 DOE/CS-34702/4 DOE/CS-34702/4 DOE/CS-340178/01-V0L-1	P0654 P0693 P0707 P0708 P0555 P0656 P0650 P0649 P0633 P0647 P0638 P0636	880-32934 # N80-28571 # N80-32548 # N80-32548 # N80-32954 # N80-32954 # N80-32527 # N80-31955 # N80-29828 # N80-29870 # N80-33288 # N80-29870 # N80-33288 # N80-33
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CONF-800352-4 CONF-8004373-1 CONF-800406-5 CONF-800439-6 CONF-800439-6 CONF-800449-1 CONF-800449-1 CONF-800449-1 CONF-800524-1 CONF-800524-3 CONF-800524-3 CONF-800529-3 CONF-800530-1 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800549-2 CONF-800549-2 CONF-800549-2 CONF-800549-2 CONF-800549-2 CONF-800604-4 CONF-800604-4 CONF-800604-4 CONF-800604-14 CONF-800604-14 CONF-800604-12 CONF-800604-22 CONF-800604-22 CONF-800604-32 CONF-800604-32 CONF-800612-3 CONF-800612-3 CONF-800612-3 CONF-800612-3 CONF-800611-3	P0640 P0655 P0655 P0656 P0652 P0632 P0638 P0638 P0638 P0639 P0639 P0585 P0709 P0585 P0709 P0642 P0642 P0642 P0642 P0642 P0642 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653 P0644 P0653	#80-29904 # #80-32947 # #80-32947 # #80-32983 # #80-29895 # #80-31538 # #80-32953 # #80-32953 # #80-29884 # #80-29884 # #80-29889 # #80-29889 # #80-29889 # #80-3293 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-32931 # #80-39933 # #80-39933 # #80-39933 # #80-329888 # #80-329888 # #80-329888 # #80-329888 # #80-329888 # #80-329888 # #80-32938 # #80-32938 # #80-32938 #	DOB/CB-00178/T2 DOB/CS-0154 DOB/CS-0161 DOB/CS-0165 DOB/CS-0168 DOB/CS-04239/T1 DOB/CS-04270/1 DOB/CS-04270/1 DOB/CS-30242/2 DOB/CS-34196/T1 DOB/CS-34196/T1 DOB/CS-34702/4 DOB/CS-0040/1 DOB/CS-0041 DOB/CS-0041 DOB/CS-0050 DOB/CS-10660/1 DOB/CST-110660/1	P0654 P0693 P0708 P0708 P0589 P0655 P0656 P0650 P0649 P0633 P0753 P0753 P07582 P07882 P07882 P07882 P07882 P07882 P07882 P07881 P0580 P058	#80-32934 # #80-32934 # #80-32944 # #80-32954 # #80-32954 # #80-32957 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32975 # #80-32977 # #80-32977 # #80-32977 # #80-32977 # #80-32977 # #80-32277 # #80-32277
CONF-800352-4 CONF-800373-1 CONF-80040-5 CONF-800421-3 CONF-800439-6 CONF-800439-11 CONF-800449-1 CONF-800446-2-REV-1 CONF-800446-1 CONF-800451-1 CONF-800524-1 CONF-800524-3 CONF-800526-1 CONF-800526-1 CONF-800526-1 CONF-800530-1 CONF-800530-1 CONF-800530-1 CONF-800549-1 CONF-800549-1 CONF-800549-1 CONF-800604-4 CONF-800604-4 CONF-800604-4 CONF-800604-16 CONF-800604-12 CONF-800604-12 CONF-800604-22 CONF-800604-22 CONF-800604-23 CONF-800604-23 CONF-800604-3 CONF-800604-22 CONF-800604-3 CONF-800604-22 CONF-800604-3 CONF-800604-22 CONF-800604-3 CONF-800604-3 CONF-800604-22 CONF-800604-3 CONF-800610-8 CONF-800610-8 CONF-800611-3 CONF-800611-8	P0640 P06551 P07522 P0633 P06566 P06584 P06584 P06666 P06587 P06698 P06698 P07629 P0587 P0587 P06667 P0667 P06687 P06687 P06687 P06687 P06688	#80-29904 # #80-32947 # #80-32947 # #80-32863 # #80-32722 # #80-29895 # #80-31538 # #80-32953 # #80-32953 # #80-29884 # #80-29887 # #80-29891 # #80-29899 # #80-29899 # #80-32931 # #80-32731 #	DOB/CB-00178/T2 DOB/CS-0154 DOB/CS-0161 DOB/CS-0165 DOB/CS-0168 DOB/CS-0468 DOB/CS-04239/T1 DOB/CS-04270/1 DOB/CS-04270/1 DOB/CS-30242/2 DOB/CS-34196/T1 DOB/CS-34196/T1 DOB/CS-34102/4 DOB/CS-34102/4 DOB/CS-34101-VOL-1 DOB/DP-03533/T2 DOB/CS-40178/01-VOL-1 DOB/DP-03533/T2 DOB/EN-0039 DOB/EN-0039 DOB/EN-0039 DOB/EN-0045 DOB/EN-0050 DOB/EN-0050 DOB/EN-0050 DOB/EN-0050 DOB/EN-0055 DOB/EN-0055 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0056 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0056 DOB/EN-0057 DOB/EN-0057 DOB/EN-0056 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-0057 DOB/EN-10634/T1 DOB/EN-110634/T1 DOB/EN-11268/3 DOB/EN-12431/T1-VOL-1	P0654 P0693 P0707 P0708 P0585 P0655 P0656 P0650 P0633 P0633 P0638 P0638 P0753 P0753 P0758 P0639 P0639 P0639 P0639 P0639 P0639 P0580 P0580 P0580 P0580 P0580 P0582 P0748 P0740	#80-32934 # #80-32934 # #80-31946 # #80-32948 # #80-32954 # #80-32957 # #80-31955 # #80-32957 # #80-32
CONF-800352-4 CONF-8004373-1 CONF-800406-5 CONF-800439-6 CONF-800439-6 CONF-800449-1 CONF-800449-1 CONF-800449-1 CONF-800524-1 CONF-800524-3 CONF-800524-3 CONF-800529-3 CONF-800530-1 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800529-3 CONF-800549-2 CONF-800549-2 CONF-800549-2 CONF-800549-2 CONF-800549-2 CONF-800604-4 CONF-800604-4 CONF-800604-4 CONF-800604-14 CONF-800604-14 CONF-800604-12 CONF-800604-22 CONF-800604-22 CONF-800604-32 CONF-800604-32 CONF-800612-3 CONF-800612-3 CONF-800612-3 CONF-800612-3 CONF-800611-3	P0640 P06551 P07522 P0633 P06566 P06584 P06584 P06666 P06587 P06698 P06698 P07629 P0587 P0587 P06667 P0667 P06687 P06687 P06687 P06687 P06688	#80-29904 # #80-32947 # #80-32947 # #80-32863 # #80-32722 # #80-29895 # #80-31538 # #80-32953 # #80-32953 # #80-29884 # #80-29887 # #80-29891 # #80-29899 # #80-29899 # #80-32931 # #80-32731 #	DOB/CB-00178/T2 DOB/CS-0154 DOB/CS-0161 DOB/CS-0165 DOB/CS-0168 DOB/CS-04239/T1 DOB/CS-04270/1 DOB/CS-04270/1 DOB/CS-30242/2 DOB/CS-34196/T1 DOB/CS-34196/T1 DOB/CS-34702/4 DOB/CS-0040/1 DOB/CS-0041 DOB/CS-0041 DOB/CS-0050 DOB/CS-10660/1 DOB/CST-110660/1	P0654 P0693 P0707 P0708 P0585 P0655 P0656 P0650 P0633 P0633 P0638 P0638 P0753 P0753 P0758 P0639 P0639 P0639 P0639 P0639 P0639 P0580 P0580 P0580 P0580 P0580 P0582 P0748 P0740	#80-32934 # #80-32934 # #80-31946 # #80-32948 # #80-32954 # #80-32957 # #80-31955 # #80-32957 # #80-32

#### REPORT/ACCESSION NUMBER INDEX

DOD/PM_100E1/2				
DOE/ET-14851/2	:			
DOE/PT-14858/T1	•	DS-ERT-21-79	p0640	#80-30349 #
DOE/ET-14876/2		·		
DQE/ET-15207/T1		DSE-3992-T1	p0705	N80-31647 <b>#</b>
DOE/ET-15209/T1	*	DSE-4042-T8	D0742	#80-28910 <b>#</b>
DOE/ET-15350/T1		DSE-4042-T16	n0654	N80-32925 #
DOE/ET-15440/1	•	DSE-4042-T30		
DODATE 13440/1 ************************************	I	DOD 1042 INC	P0043	NOU-30940 #
DOR/ET-20090/3 p0654 #80-32929		DSE-4042-T40	P0645	N80-31904 #
DOE/ET-20279/92:		DSE-5235-T1	p0653	N80-32913 #
DOB/ET-20279/93				
DOR/ET-20419/1	#	D1-1980	p0634	N80-29537 #
DOE/ET-20550/1			P 102 .	
		n-200	-0600	****
DOE/ET-20567/1-1		E-398		
DOE/ET-20567/1-2-BK-1 p0645 N80-31896		B-440		
DOR/RT-20567/1-2-BK-2 p0645 #80-31897	*	E-469	p0656	N80-33465*#
DOE/ET-20611/11	*	E-474	p0755	N80-33357*#
DOE/ET-21050/1-1		E-506	D0583	NBO-31002*4
DOE/ET-21050/1-2 p0586 #80-32868		E-514		
DOE/ET-21050/1-3-VOL-3 p0587 #80-32893		E-516	p0743	N80-29862*#
DOE/ET-21074/4 p0653 #80-32921		E-520	p0695	N80-29502*#
DOE/ET-23005/T3		E-531	p0585	N80-32395**
DOR/RT-23006/3	. # 1	,		
DOE/ET-23007/1		PHD_00_014	-0760	NOO 34030 #
DE/ 51 - 2300 / / 1	I 1	BMD-80-41		
DOR/ET-23023/T3		EMD-80-64	P0638	N80-29880 #
DOB/ET-23044/4	*	,		
DOE/ET-25502/1 p0753 #80-32878		BPA-AA-IMS/ST-80-4	p0590	N80-33018 #
DOE/ET-26931/T1			-	
DOE/EV-0061/3		EPA-AA-TABB-80-10	20502	NBU-3005# #
DOE/EV-0001/3	: I		20202	#UU-3V304 ₹
DOE/EV-0074		EPA-600/3-80-040		
DOE/RV-0077	#	EPA-600/3-80-041		
DOE/EV-0079 p0588 #80-32972		BPA-600/7-79-144		
DOR/EV-0084 p0589 N80-32989		EPA-600/7-79-200		
DOE/EV-02057/T2 p0695 #80-29506	: 1	EPA-600/7-80-013		
DOE/FR-0003/79-2		EPA-600/7-80-017B-VOL-2		
DOE/FE-0004/79-2 p0709 N80-32555	*	BPA-600/7-80-017D-VOL-4	p0698	N80-30313 #
DOE/PE-2614/3	*	EPA-600/7-80-038	pQ582	N80-30966 #
DOB/IA-0001T/3(80)		EPA-600/7-80-043		
DOE/IA-0010	- I	EPA-600/7-80-046A-VOL-1	20707	NOO-31990 +
		EPR-000/7-00-040A-101-1	P0707	NOU-31990 #
DOE/JPL-1012-44	**	EPA-600/7-80-051	p0593	N80-33980 ₩
DOE/JPL-1060-30-REV-1 p0636 N80-29858		EPA-600/7-80-093	p0589	N80-32995 #
DOR/JPL-954654-80/11	**	EPA-600/9-79-040	p0561	880-29928 #
DOB/JPL-954739-3	*#	•	-	
DOR/JPL-955614-80/1 p0650 N80-32855		BPRI-AP-1225	n/1644	NBO-30507 #
DOE/MC-08089/T4	.	BPRI-AF-1233		
DOE/MC-08484/T1		BPRI-AF-1243		
DOE/NASA/0030-80/3-VOL-3 p0748 #80-31869	**	EPBI-AF-1291	p0692	N80-28567 #
DOE/NASA/0031-80-2	*#			
DOE/NASA/0031-80/3-VOL-3 p0749 N80-31870		EPRI-AP-1316	n0753	N80-32881 #
DOE/NASA/0031-80/4-VOL-4 p0755 N80-33859		EPRI-AP-1317		
DOD/ MADA 10024 0015	II I			
DOE/NASA/0031-80/6 p0591 N80-33860		BPRI-AP-1345		
DOE/NASA/0031-80/6-VOL-6-PT-1B p0745 N80-30889		BPRI-AP-1351		
DOE/NASA/0031-80/6-VOL-6-PT-2 p0745 N80-30890	*# [	BPRI-AP-1300	p0713	N80-33601 #
DOE/NASA/0031-80/6-VOL-6-PT-2 p0591 N80-33861	*#		-	
DOE/NASA/0031-80/6-VOL-6-1A p0745 H80-30888		EPRI-EA-13/7	n0589	N80-32987 #
DOE/NASA/0038-80/2 p0775 N80-29857			F-10-1	
DOE/NASA/0096-1	II l	DDDT DW 400/	- 0350	WOO 24022 A
		EPRI-EM-1286	P0/50	NOU-3 1937 #
DOE/HASA/0100-79/1		EPRI-RM-1328		
DOE/NASA/0116-80/1 p0777 N80-32299	<b>*</b> #	BPRI-EM-1333	p0752	N80-32866 #
DOE/NASA/0124-3	*#	EPRI-EM-1417	p0778	N80-32917 #
DOB/NASA/0134-1		• • • • • • • • • • • • • • • • • • • •	_	
DOB/NASA/0161-4		BPRI-ER-1282-SB	D0632	NAG-28890 #
DOE/NASA/1062-6		EPRI-ER-1299-SR	20624	100 20070 W
		EEL-DE-1477-35	P002 1	BUU-200/7 #
DOE/NASA/2674-12	I .	707 DO 70 C		**** *** *
DOE/NASA/2749-79/2-VOL-2 p0751 N80-32719 DOE/NASA/23139-1 p0752 N80-32858	<del></del> -	EPRI-PS-79-5-LD	p0578	N80-28918 #
DOE/NASA/23139-1	**			
DOB/PC-10346/1	# Ì	BRC-LIB-80121	p0584	N80-31796*#
DOR/PC-20041/T1 D0712 N80-33520	#			
DOE/PC-30014/1	i	BRC-6154-I	50705	NOO-20005 #
non/np_70000 mg -0240	:	VIJT A	PO 143	#40-70202 A
DOB/PB-70048/T2	: I	701 07 17 1201		
DOE/PETC-TR-80/5	₹	ESA-CR(P)-1301	pu640	M80-30348 #
DOE/TIC-11114	<b>#</b>	ESA-CR(P)-1314	p0640	N80-30349 <b>#</b>
DOB/TIC-11190 p0654 N60-32928		•		
	ı	RSA-SP-147	p0658	N80-33873 #
DOT-HS-805130 p0585 N80-32734	ای		-0000	53513 4
		PCC-70-30-801-1	-06#0	#00-340#0 #
DOT-HS-805133	• 1	BSG-79-30-VOL-1		
DOT-HS-805239 p0586 H80-32735	₽	BSG-79-30-VOL-2-BK-1	p0645	№80-31896 #
•	ı	BSG-79-30-VOL-2-BK-2	p0645	¥ 7881E-08≝
DOT-ESPA-DPB-50-79-1 p0777 #80-31278	* I		-	
DOT-ESPA-DPB-50-80-1-VOL-1 p0698 880-30470		EUR-64236N	n0637	N80-29877 #
DOT-RSPA-DPB-50-80-2-VOL-2 p0698 R80-30470	i	EUR-6681/I-EB		
DOT-RSPA-DPB-50-80-7 p0584 880-31968	•	BUR-6696-RB		
		BUR-6711-DB		
DOT-TSC-NHTSA-79-38 p0585 #80-32734	•	BUB-6748-BB		
DOT-ISC-NHISA-79-40 p0586 N80-32735	#		-	
DOT-TSC-NHTSA-79-40	4 L	EXXOS/GEU. 18GFGS.79	p0712	NBO-32999 #
207 2170% 12 22	·			
DREG-TH-79-30	.	B80-10279	-0600	E00-2002244
ΔΕΡΟ-ΤΗ-13-30 ************* ΜΑΙΟΛ ΝΟΛ-223ΑΩ	<del>*</del> 1	DUV-18217	FOOR	#UU-43044 <del>*</del>

#### BEPORT/ACCESSION NUMBER INDEX

	GPO-51-721	n0590	N80-33581 #
FE-1514-97 p0700 #80-30548 #	GPO-55-634		
PB-1514-101p0703 N80-31634 #	GPO-56-541		
PE-1514-113p0709 880-32557 #	GPO-59-139		
FE-1800-45	GPO-59-826		
FE-1806-67 p0693 H80-28726 #	GPO-61-213-VOL-5		
PB-1806-83 p0752 N80-32729 #	GPO-61-774-VOL-2		
PE-1806-84		P ****	200 30221 1
PE-1806-86	HAC-E3256	n0630	N80~28863**
PE-2006-16	THE BOLON	P0030	#00-\$0003+#
FE-2006-17 p0700 H80-30549 #	HCP/M1693-03	n0579	* 8580c-084
PE-2044-51 p0699 N80-30540 #	201/21075 05 00000000000000000000000000000000	P 4373	200 2000 1
PE-2211-11 p0704 H80-31642 #	HD-1-80/2	n0578	N80-28035 #
PR-2305-30	25 1 00/2 .	P43.0	200 20733 .
FE-2305-33	HI-79188	n0775	N80-29857##
PE-2306-35 p0696 B80-29514 #	M2 17100	20113	HOU 23037.4
FE-2306-38 p0696 N80-29513 #	HP-1-80/1	n0578	N80-28934 #
PE-2315-40		-	
PE-2315-45 p0699 880-30544 #	HUD-0001443	D0656	N80-32961 #
FE-2315-48	800-0001443	Pooso	#00-32301 ¥
PE-2416-44-VOL-1 p0690 N80-28542 #	IAP-79-174	n0637	N80-29878 #
	IRF-13-114	P0031	B00-23070 ¥
FE-2416-44-VCL-2 p0690 B80-28543 # FE-2434-33A p0703 B80-31630 #	IITRI-D6169	50701	# 000-2000# #
	111R1-D0103	P0101	800-30304 #
	IITBI-M6043-5	50700	NOV- 34640 4
	TIMBI-MCVES ************************************	P0704	NOU-31040 #
	IITRI-86052	P0/01	307-30304 <b>#</b>
PE-2468-68	IKE-K-54-20-PT-1	ոներգ	N80-3297# #
FE-2566-33	AND ROJE CUTET. CONCOMMENCE CONC	FOTOR	BOV-32314 #
FE-2595	INKA-CONF-79-378-046	n0627	N80-29878 *
PB-2595-5		50001	200 20070 \$
FE-2621-13	INPE-1792-RPE/164	n0712	NAG-32937 #
FE-2666-F-V0L-2 p0711 H80-32720 #	1176 BEB/ 107 *************	20112	200-22031 #
PE-2696-T4	IR-2	n0699	N80-30544 *
PE-2702-8	IR-2		
FE-2702-10	IR-2-VOL-1		
PE-2729-8 p0699 N80-30541 #	IR-2-VOL-2	20770	M8U-3U0U8 #
FE-2762-8 p0577 N80-28557 #	10 2 100 2 1100 1100 1	P0.40	BOU 30300 F
PE-2806-5 p0704 N80-31637 #	IS-4724	n0648	N80-31952 #
PE-2895-7 p0751 N80-32231 #	15-4/24	P0040	800-31932 ¥
FE-3044-T6 p0690 N80-28548 #	ISBN-0-309-03039-0	n0579	N80-29156 #
FE-3044-T7 p0704 N80-31635 #	ISBN-0-7988-1467-5	n0755	N80-33868 #
PE-3105-1	ISBN-0-7988-1665-1		
PE-3125-12 p0704 N80-31638 #	ISBN-0-7988-1667-8		
FB-3125-18	ISBN-0-7988-1730-5		
FE-3137-T1	ISBN-0-7988-1730-5		
PE-3177-5	ISBN-0-7988-16651		
FE-3240-T4	ISBN-3-7041-0038-2		
FE-3240-T5	ISBN-90-6144-091-2		
FB-3274-1	ISBN-90-6144-092-0		
PE-3297-1 p0690 N80-28482 #	ISBN-91-540-3157-5		
PE-3297-2p0690 N80-28545 #	ISBN-92-835-0261-2	p0743	N80-29342 #
PE-3297-3p0690 N80-28546 #			
FE-8917-2 p0743 N80-29741 #	ISD-243	p0747	N80-30948 #
FE-14809-1	ISD-244	p0747	N80-30949 #
PE-15529-5p0748 N80-31222 #	ISD-258	p0747	N80-30950 #
		•	
PPA-AU-1499-PT-6	ISM-245		
PPA-AU-1499-PT-10	100 273 *********************	p0702	N80-30929 #
	ISH-246	p0702 p0690	N80-30929 # N80-28549 #
· , 1	ISM-246	p0690	N80-28549 #
FPA-HU-2126	ISM-246	p0690	N80-28549 #
PPA-HU-2126 p0742 880-28933 #	ISB-246  ISSN-0110-1692 ISSN-0170-6071	p0690 p0710	N80-28549 # N80-32571 #
	ISB-246  ISSB-0110-1692  ISSB-0170-6071  ISSB-0170-6071	p0690 p0710 p0747 p0747	N80-28549 # N80-32571 # N80-30948 # N80-30949 #
PPR-24 p0742 N80-28933 # PPR-24 p0759 N80-30656 #	ISB-246	p0690 p0710 p0747 p0747	N80-28549 # N80-32571 # N80-30948 # N80-30949 #
PPR-24 p0759 N80-30656 #  PR-11405-VOL-2 p0744 N80-29922 #	ISN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608	p0690 p0710 p0747 p0747 p0747 p0776	N80-28549 # N80-32571 # N80-30948 # N80-30949 # N80-30950 # N80-29905 #
PPR-24 p0759 N80-30656 #	ISN-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071	p0690 p0710 p0747 p0747 p0747 p0776	N80-28549 # N80-32571 # N80-30948 # N80-30949 # N80-30950 # N80-29905 #
PPR-24 p0759 N80-30656 #  PR-11405-VOL-2 p0744 N80-29922 # PR-11405-VOL-4 p0698 N80-30313 #	ISN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608	p0690 p0710 p0747 p0747 p0747 p0776 p0640	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29906 #
PPR-24 p0759 N80-30656 #  PR-11405-VOL-2 p0744 N80-29922 # PR-11405-VOL-4 p0698 N80-30313 #	ISB-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608	p0690 p0710 p0747 p0747 p0747 p0747 p0776 p0640 p0640	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29906 #  N80-29907 #
PPR-24	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0340-7608 ISSB-0340-7608	p0690 p0710 p0747 p0747 p0747 p0747 p0776 p0640 p0640	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29906 #  N80-29907 #
PPR-24 p0759 N80-30656 #  PR-11405-VOL-2 p0744 N80-29922 # PR-11405-VOL-4 p0698 N80-30313 #	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSB-0340-7608 ISSB-0340-7608 ISSB-0340-7608 JHU/APL/EQB/80-1	p0690 p0710 p0747 p0747 p0747 p0747 p0776 p0640 p0640	N80-28549 # N80-32571 # N80-30948 # N80-30949 # N80-30950 # N80-29905 # N80-29906 # N80-29907 # N80-33919 #
PPR-24	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608 JHU/APL/EQB/80-1  JPL-PUB-79-82	p0690 p0710 p0747 p0747 p0747 p0746 p0640 p0640 p0783	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-32827*#
PPR-24	ISB-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-82 JPL-PUB-79-95-REV-1	p0690 p0710 p0747 p0747 p0747 p0747 p07640 p0640 p0783 p0586 p0636	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-29858*#
PPR-24	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSB-0340-7608 ISSB-0340-7608 JSB-0340-7608 JHU/APL/EQR/80-1 JPL-PUB-79-82 JPL-PUB-79-95-REV-1 JPL-PUB-80-27	p0690 p0710 p0747 p0747 p0747 p0747 p0640 p0640 p0783 p0586 p0636 p0650	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-29858*#  N80-32852*#
PPR-24	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSN-0340-7608 ISSB-0340-7608 ISSB-0340-7608 JHU/APL/EQB/80-1  JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-35	P0690 P0710 P0747 P0747 P0747 P0747 P07640 P0640 P0783 P0586 P0650 P0650	N80-28549 #  N80-32571 #  N80-30948 #  N80-30950 #  N80-29905 #  N80-29907 #  N80-32919 #  N80-32827*#  N80-32827*#  N80-32827*#  N80-32852*#  N80-32860*#
PPR-24	ISB-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608 JHU/APL/EQB/80-1  JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-35 JPL-PUB-80-43	P0690 P0710 P0747 P0747 P0747 P0747 P0640 P0640 P0783 P0586 P0636 P0636 P0636	N80-28549 #  N80-32571 #  N80-30948 #  N80-30950 #  N80-29905 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-32827*#  N80-32852*#  N80-29850*#  N80-29859*#
PPR-24 p0759 N80-30656 #  PR-11405-VOL-2 p0744 N80-29922 # PR-11405-VOL-4 p0698 N80-30313 #  PRC-C4772-2 p0656 N80-32952 #  PWS/OBS-80/28 p0588 N80-32964 #  GA-A-15777-REV p0666 N80-31651 # GA-A-15823 p0633 N80-29505 #  GDC-ASP-80-015 p0759 N80-29645*#	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSB-0340-7608 ISSB-0340-7608 ISSB-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-35 JPL-PUB-80-43 JPL-PUB-80-43 JPL-PUB-80-48-V0L-1	P0690 P0710 P0747 P0747 P0747 P0746 P0640 P0783 P0586 P0636 P0650 P0760	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-32852*#  N80-29860*#  N80-29869*#  N80-29859*#
PPR-24	ISM-246  ISSM-0110-1692 ISSM-0170-6071 ISSM-0170-6071 ISSM-0170-6071 ISSM-0340-7608 ISSM-0340-7608 ISSM-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-27 JPL-PUB-80-27 JPL-PUB-80-43 JPL-PUB-80-48 JPL-PUB-80-49	P0690 P0710 P0747 P0747 P0747 P0746 P0640 P0783 P0586 P0636 P0776 P0636 P0776 P0636 P0776 P0636	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-29858*#  N80-29858*#  N80-29859*#
PPR-24	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSB-0340-7608 ISSB-0340-7608 ISSB-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-35 JPL-PUB-80-43 JPL-PUB-80-43 JPL-PUB-80-48-V0L-1	P0690 P0710 P0747 P0747 P0747 P0746 P0640 P0783 P0586 P0636 P0776 P0636 P0776 P0636 P0776 P0636	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-29858*#  N80-29858*#  N80-29859*#
PPR-24	ISB-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-35 JPL-PUB-80-43 JPL-PUB-80-49 JPL-PUB-80-49 JPL-PUB-80-72	P0690 P0710 P0747 P0747 P0747 P0747 P0640 P0640 P0783 P0586 P0636 P0636 P0636 P0636 P0760 P0580 P0714	N80-28549 # N80-32571 # N80-30948 # N80-30949 # N80-30950 # N80-29906 # N80-29906 # N80-29907 # N80-33919 # N80-32852*# N80-32852*# N80-29858*# N80-29858*# N80-29859*# N80-29859*# N80-29859*# N80-29861*# N80-29861*# N80-34093*#
PPR-24	ISB-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608 ISSN-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-95-REV-1 JPL-PUB-80-27 JPL-PUB-80-48 JPL-PUB-80-48 JPL-PUB-80-49 JPL-PUB-80-49 JPL-PUB-80-72	P0690  P0710 P0747 P0747 P0747 P0776 P0640 P0783  P0586 P0650 P0776 P0636 P0776 P0636 P07714 P0630	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-32827*#  N80-29858*#  N80-29860*#  N80-29860*#  N80-29861*#  N80-34093*#  N80-28863*#
PPR-24	ISB-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608 JHU/APL/EQR/80-1 JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-35 JPL-PUB-80-43 JPL-PUB-80-43 JPL-PUB-80-43 JPL-PUB-80-49 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-72 JPL-9950-377 JPL-9950-378	P0690 P0710 P0747 P0747 P0747 P0747 P0740 P0640 P0783 P0586 P0636 P0636 P0760 P0780 P0714 P0631	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-33827*#  N80-32852*#  N80-32852*#  N80-32852*#  N80-29860*#  N80-29861*#  N80-29861*#  N80-28863*#  N80-28863*#
PPR-24	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSB-0340-7608 ISSB-0340-7608 ISSB-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-95-REV-1 JPL-PUB-80-27 JPL-PUB-80-35 JPL-PUB-80-48 JPL-PUB-80-49 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-72	P0690 P0710 P0747 P0747 P0747 P0747 P0640 P0640 P0783 P0586 P0650 P0776 P0650 P07660 P0776 P0776 P0630 P0714 P0630 P0665	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-32827*#  N80-32852*#  N80-29850*#  N80-29850*#  N80-29860*#  N80-29861*#  N80-28863*#  N80-28864**  N80-28864**
PPR-24	ISB-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-95-REV-1 JPL-PUB-80-27 JPL-PUB-80-43 JPL-PUB-80-43 JPL-PUB-80-49 JPL-PUB-80-72  JPL-PUB-80-72  JPL-PUB-80-72  JPL-PUB-80-72  JPL-PUB-80-73 JPL-PUB-80-73 JPL-PUB-80-73 JPL-PUB-80-73 JPL-PUB-80-73 JPL-9950-379 JPL-9950-379 JPL-9950-379 JPL-9950-379 JPL-9950-379 JPL-9950-379	P0690 P0710 P0747 P0747 P0747 P0776 P0640 P0783 P0586 P0636 P0776 P0636 P0776 P0636 P0776 P0580 P0714 P0631 P0631 P06631 P06667	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-32827*#  N80-29858*#  N80-29850*#  N80-29860*#  N80-29861*#  N80-31268*#  N80-31268*#  N80-34093*#  N80-28864*#  N80-28864*#  N80-28865*#  N80-3859*#  N80-3859*#  N80-3959*#  N80-29859*#  N80-39859*#  N80-29859*#  N80-29859*#  N80-39859*#  N80-39859*#  N80-39859*#  N80-39859*#  N80-39859*#  N80-39859*#  N80-39859*#  N80-39859*#  N80-39859*#
PPR-24	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSB-0340-7608 ISSB-0340-7608 ISSB-0340-7608 ISSB-0340-7608 JHU/APL/EQB/80-1  JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-27 JPL-PUB-80-35 JPL-PUB-80-48 JPL-PUB-80-48 JPL-PUB-80-49 JPL-PUB-80-72  JPL-9950-377 JPL-9950-378 JPL-9950-379 JPL-9950-379 JPL-9950-406 JPL-9950-406	P0690 P0710 P0747 P0747 P0747 P0776 P0640 P0783 P0586 P0636 P0676 P0760 P0776 P0636 P0776 P0630 P0714 P0631 P0665 P0665	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29907 #  N80-29907 #  N80-32827*#  N80-32827*#  N80-32827*#  N80-32852*#  N80-29869*#  N80-29869*#  N80-29869*#  N80-29861*#  N80-28863*#  N80-28863*#  N80-28865*#  N80-28865*#  N80-32855*#  N80-32855*#  N80-32855*#
PPR-24	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSB-0340-7608 ISSB-0340-7608 ISSB-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-43 JPL-PUB-80-49 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-79 JPL-9950-377 JPL-9950-379 JPL-9950-406 JPL-9950-408 JPL-9950-408 JPL-9950-413	P0690 P0710 P0747 P0747 P0747 P0747 P076 P0640 P0783 P0586 P0650 P0776 P0630 P0714 P0630 P0667 P0667 P0667	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-32852*#  N80-32852*#  N80-29860*#  N80-29860*#  N80-29861*#  N80-28863*#  N80-28864*#  N80-28865*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#
PPR-24	ISB-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-95-REV-1 JPL-PUB-80-27 JPL-PUB-80-48 JPL-PUB-80-49 JPL-PUB-80-49 JPL-PUB-80-72  JPL-PUB-80-49 JPL-PUB-80-72  JPL-PUB-80-72  JPL-PUB-80-72  JPL-PUB-80-48 JPL-PUB-80-72  JPL-PUB-80-72  JPL-9950-377 JPL-9950-379 JPL-9950-406 JPL-9950-406 JPL-9950-413 JPL-9950-413 JPL-9950-416	P0690 P0710 P0747 P0747 P0747 P0776 P0640 P0783 P0586 P0636 P0776 P0636 P0776 P0636 P0776 P0580 P0714 P0631 P06657 P0650 P07650 P07650	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-32827*#  N80-29858*#  N80-29860*#  N80-29860*#  N80-29861*#  N80-31268*#  N80-31268*#  N80-3865*#  N80-28864*#  N80-28865*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#
PPR-24	ISB-246  ISSB-0110-1692 ISSB-0170-6071 ISSB-0170-6071 ISSB-0170-6071 ISSB-0340-7608 ISSB-0340-7608 ISSB-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-82 JPL-PUB-80-27 JPL-PUB-80-43 JPL-PUB-80-49 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-72 JPL-PUB-80-79 JPL-9950-377 JPL-9950-379 JPL-9950-406 JPL-9950-408 JPL-9950-408 JPL-9950-413	P0690 P0710 P0747 P0747 P0747 P0776 P0640 P0783 P0586 P0636 P0776 P0636 P0776 P0636 P0776 P0580 P0714 P0631 P06657 P0650 P07650 P07650	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29907 #  N80-33919 #  N80-32827*#  N80-32827*#  N80-29858*#  N80-29860*#  N80-29860*#  N80-29861*#  N80-31268*#  N80-31268*#  N80-3865*#  N80-28864*#  N80-28865*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#  N80-32855*#
PPR-24	ISB-246  ISSN-0110-1692 ISSN-0170-6071 ISSN-0170-6071 ISSN-0170-6071 ISSN-0340-7608 ISSN-0340-7608 ISSN-0340-7608 JHU/APL/EQR/80-1  JPL-PUB-79-95-REV-1 JPL-PUB-80-27 JPL-PUB-80-48 JPL-PUB-80-49 JPL-PUB-80-49 JPL-PUB-80-72  JPL-PUB-80-49 JPL-PUB-80-72  JPL-PUB-80-72  JPL-PUB-80-72  JPL-PUB-80-48 JPL-PUB-80-72  JPL-PUB-80-72  JPL-9950-377 JPL-9950-379 JPL-9950-406 JPL-9950-406 JPL-9950-413 JPL-9950-413 JPL-9950-416	P0690  P0710 P0747 P0747 P0747 P0747 P0766 P0640 P0783  P0586 P0636 P0776 P0636 P0776 P0636 P0776 P0636 P0777 P0651 P0651 P0644	N80-28549 #  N80-32571 #  N80-30948 #  N80-30949 #  N80-30950 #  N80-29905 #  N80-29906 #  N80-29907 #  N80-33919 #  N80-32852*#  N80-32852*#  N80-29860*#  N80-29860*#  N80-29861**  N80-3868*#  N80-3868*#  N80-38852*#  N80-28863*#  N80-28863*#  N80-28865*#  N80-32855*#  N80-32855*#

#### BEPORT/ACCESSION NUMBER INDEX

	WICH OR 464202		
WWD_E0/7-072-WAY-1 -0505 W00-31002 4	NASA-CR-161202	p0657	N80-33865*#
KVB-5807-842-VOL-1	NASA-CR-161203		
4 C9611C-000 C0C0q	NASA-CR-161480	P0630	NOO-20001+4
LA-UR-80-746 p0632 B80-28891 #			
LA-UR-80-853	NASA-CR-161483		
LA-UR-80-1094 p0711 N80-32573 #	NASA-CR-161485		
LA-UR-80-1426	NASA-CR-161491		
22 02 00 1420 111111111111 poros 200 32302 V	NASA-CR-161492		
LA-7831-PR	NASA-CR-161493		
LA-8155-Cp0690 N80-28547 #	NASA-CR-161494		
LA-8308-MSp0588 N80-32973 #	NASA-CR-161495		
LA-8323-PRp0759 N80-30656 #	NASA-CR-161508		
LA-8375-PRp0754 N80-33233 #	NASA-CR-161509		
LA-8398-MSp0592 M80-33969 #	NASA-CR-161510		
• • • • • • • • • • • • • • • • • • • •	NASA-CR-161512		
LBL-9789 p0705 N80-31646 #	NASA-CR-161513		
LBL-9870 p0703 N80-31628 #	NASA-CR-161520	p0641	N80-30896*#
LBL-10034 p0640 N80-29903 #	NASA-CR-161537		
LBL-10058	NASA-CR-161538		
LBL-10248p0760 N80-31923 #	NASA-CR-161539		
LBL-10293	NASA-CR-161543		
LBL-10320 p0582 N80-30942 #	NASA-CR-161546		
LBL-10456	NASA-CR-161548		
LBL-10716	NASA-CR-161549	p0657	N80-33858*#
LBL-10770	NASA-CR-161558		
LBL-10771	NASA-CR-161562		
LBL-10791	NASA-CR-163046		
LBL-10802	NASA-CR-163049	p0750	N80-31951*#
·	NASA-CR-163327		
LC-80-80730 p0579 N80-29156 #	NASA-CR-163328	p0580	N80-29887*#
LC-80-600092 p0591 N80-33922 #	NASA-CR-163329	p0639	N80-29897*#
	NASA-CR-163345	p0698	N80-29822*#
LR-29157	NASA-CR-163386		
	NASA-CR-163392	p0665	N80-28865*#
MCR-79-1369	NASA-CR-163432	p0636	N80-29858*#
	NASA-CR-163434		
METC-8450-T1	NASA-CR-163436	p0636	N80-29859*#
METC-8450-T2-VOL-1 p0707 N80-31912 #	NASA-CR-163477	p0760	N80-31268*#
· .	NASA-CR-163479	p0639	N80-29900*#
MIT-EL-79-012-VOL-1 p0697 N80-29524 #	NASA-CR-163513	p0644	N80-31875*#
MIT-EI-79-021 p0581 N80-30234 #	NASA-CR-163518	p0644	N80-31877*#
	NASA-CR-163522		
MLM-2721 p0702 B80-31506 #	NASA-CR-162523		
/	NASA-CR-163535		
MTI-79TR5 p0710 N80-32572 #	NASA-CR-163568		
	NASA-CR-163570		
NAE-ANTS-1979 p0579 N80-29156 #	NASA-CR-163583	p0651	N80-32857*#
77.7 TV F#	NASA-CR-163584		
NAL-TN-54 p0743 N80-29844 #	NASA-CR-163585		
WIGH GIGH ING 44243 2	NASA-CR-163586		
NASA-CASE-ARC-11243-2 p0583 N80-31472*#	NASA-CR-163595	PU/11	N8U-325/84#
NASA-CASE-LEW-12918-1	NASA-CR-163596	PU/82	NOU-34403+#
MADA-CADA-DAW-125 to-1 potou mou-33037**			
NASA-CASE-NPO-13786-1	NASA-CR-165156	50122	NOU-33002+#
NASA-CASE-NPO-15179-1 p0650 N80-32850*#	NASA-SP-7046 (03)	0644	NOA-32010+
NASA-CASE-NPC-15183 p0634 N80-32830-4	BBB-3F-7040 (03)	20049	NOV-3241V+
MASA-CASE W20-15105	NASA-TM-75822	-07#Q	NO.0-2100144
NASA-CP-2146	NASA-TH-75822	n06##	NRO-31879±#
NASA-CP-2154	NASA-TM-81136 :		
page 500 000 000 000 000 000 000 000 000 00	NASA-TH-81142		
NASA-CR-3317	NASA-TM-81502		
NASA-CR-3318p0760 N80-31890*#	NASA-TH-81554		
NASA-CR-3320p0651 N80-32860*#	NASA-TM-81555	0754	N80-33221*#
NASA-CR-3322	NASA-TM-81559	0695	N80-29502*#
NASA-CR-3323p0651, N80-32859*#	NASA-TM-81566		
NASA-CR-3324p0759 N80-30900*#	NASA-TM-81577	0583	N80-31402*#
NASA-CR-159320	•		
NASA-CR-159671	NASA-TP-1729	p0755	N80-33357*#
NASA-CR-159708		-	
NASA-CR-159727	NBS-SP-544	p0634	N80-29534 #
NASA-CR-159761	(		
NASA-CR-159766p0741 N80-28859*#	NBSIR-80-1991	p0748	N80-30955 #
NASA-CR-159767p0749 N80-31870*#	NBSIR-80-2052	p0583	N80-31673 #
NASA-CR-159768			
NASA-CR-159770-PT-1 p0591 N80-33860*4	NOAA-NWS-WRCP-9	p0714	NBO-34052 #
NASA-CR-159770-PT-1-A p0745 N80-30888*#	NO. 1 00054202		
NASA-CR-159770-PT-1-B	NOAA-80051302	P0714	N80-34052 <b>#</b>
NASA-CR-159770-PT-2 p0745 N80-30890*#	NP-24333 p	0501	
NASA-CR-159770-PT-2 p0591 N80-33861*#	яг-24333 р мп-24233	PUS91 .	NOO-30047
NASA-CR-159811	NP-24377	PU043	MOU-30947 #
NASA-CR-159834	NDT_ND_0157 -	07/14	NOA-20063 #
NASA-CR-159845	NRL-MR-4157	2074] ) 2077?	000-2000/ <b>₹</b>
NASA-CR-159868	NRL-HR-4267 P	PO / / /	uon_27907 #
NASA-CR-159882	NSWC/TR-79-247 p	00634	N80-28860 A
NASA-CR-159888	мыныу дан туначи положения в р	, , ,	#UU-20007 #
NASA-CR-160796	NTIS/PS-78/0302 P	0781	N80-28681 #
The fraction of the state of th			

#### . BEPORT/ACCESSION NUMBER INDEX

HTIS/PS-78/0304	
NOTE /DE_ 70 /AA4/ A754 NAA 346/E B	PB80-173552 p0693 N80-28574 #
HTIS/PS-78/0416	PB80-173644
NTIS/PS-78/0417p0748 N80-30957 #	FB80-174030p0649 N80-31963*#
NTIS/PS-78/0499 p0706 N80-31660 #	PB80-175185
	TD00 175103 ************************************
NTIS/PS-78/0500	FB80-175300 p0777 N80-31278 #
NTIS/PS-78/0547 p0665 N80-30561 #	FB80-175334
NTIS/PS-78/0578 p0748 N80-30954 #	PB80-175375 p0634 N80-29537 #
NTIS/PS-78/0586 p0782 B80-33918 #	FB80-175607
NTIS/PS-78/0591	PB80-175755
NTIS/PS-78/0660	PB80-177413
BTIS/PS-78/0661	PB80-177942 p0581 N80-29928 #
HTIS/PS-78/0674 p0711 H80-32582 #	PB80-178213 p0698 N80-30470 #
	PB80-178221 p0698 N80-30471 #
NTIS/PS-78/0690 p0780 N80-33924 #	PB80-179245
NTIS/RS-78/0831	PB80-179849
HTIS/PS-78/0831 p0783 N80-34300 #	PB80-181274
NTIS/PS-79/0298	PB80-181555
NTIS/PS-79/0299 p0781 N80-28683 #	PB80-181563 p0583 N80-31027 #
NTIS/PS-79/0337p0782 B80-32965*#	FB80-182355
NTIS/PS-79/0534 p0751 N80-31965 #	PB80-182769
NTIS/PS-79/0536	PB80-182819
BTIS/PS-79/0541	FB80-184229
NTIS/PS-79/0545	PB80-184518
NTIS/PS-79/0547 p0711 N80-32579 #	FB80-184526
	PB80-184534
NTIS/PS-79/0596	PB80-184542
NTIS/PS-79/0608	PB80-185002
NTIS/PS-79/0639 p0782 N80-33918 #	FB80-187305
	PB80-187594
NTIS/PS-79/0676 p0779 H80-32968 #	PB80-187602
NTIS/PS-79/0714	PB80-187719
NTIS/PS-79/0779 p0667 N80-33607 #	FB80-188121 p0712 N80-32999 #
NTIS/PS-79/0780	PB80-188378
NTIS/PS-79/0782 p0780 N80-33924 #	PB 80-189244 p0656 N80-32961 #
NTIS/PS-79/0841 p0783 N80-34299 #	FB80-189574
NTIS/PS-79/0841 p0783 N80-34300 #	PB80-190010
	PB 80-190655
NZERDC-49 p0710 H80-32571 #	FB80-190796
BBBB 0-43	
	PB 80-191836 p0586 N80-32736 #
ONERA, TP NO. 1980-28 p0597 A80-46228 #	PB80-192123
	PB80-192156
ONWI-24p0585 N80-32203 #	PB 80-192453
	D00-10260E -0506 N00-1273E A
	PB80-192685 p0586 N80-32735 #
ORAU/IRA-80-4(M)	PB80-193253
ORAU/IEA-80-9(M) p0589 N80-32983 #	PB 80-193659
· ·	FB80-193709
ORNL-1310 p0580 N80-29868 #	PB80-193725 p0714 N80-33920 #
	PD00 133723 **********************************
ORNL-5630 p0707 N80-31902 #	FB80-195019
	FB80-195316 p0783 N80-33919 #
ORNL/CON-38	PB80-196041
ORNL/CON-42 p0587 N80-32880 #	FB80-196850
ORNL/CON-43p0587 N80-32904 #	PB80-197759
ORNL/CON-43	PB80-197759
ORNL/CON-43 ORNL/CON-46 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-7470/1-V1 ORNL/SUB-7470/1-V1 ORNL/TH-7022 ORNL/TH-7022 ORNL/TH-7346 ORNL/SUB-746/14 ORNL/SUB-746/	PB80-197759
ORNL/CON-43	PB80-197759
ORNL/CON-43 ORNL/CON-46 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-7470/1-V1 ORNL/SUB-7470/1-V1 ORNL/TH-7022 ORNL/TH-7022 ORNL/TH-7346 ORNL/SUB-746/14 ORNL/SUB-746/	PB80-197759
ORBL/COM-43 ORBL/COM-46 ORBL/SUB-79/45740/1 ORBL/SUB-79/45740/1 ORBL/SUB-7470/1-V1 ORBL/SUB-7470/1-V1 ORBL/TH-7022 ORBL/TH-7319 ORBL/TH-7319 ORBL/TH-7346 ORBL/TH	PB80-197759
ORNL/CON-43	PB80-197759
ORNL/CON-43	PB80-197759
ORBL/COM-43 ORBL/COM-46 ORBL/SUB-79/45740/1 ORBL/SUB-79/45740/1 ORBL/SUB-7470/1-V1 ORBL/SUB-7470/1-V1 ORBL/TH-7022 ORBL/TH-7319 ORBL/TH-7319 ORBL/TH-7346 ORBL/TH	PB80-197759
ORBL/COM-43 ORBL/COM-44 ORBL/SUB-79/45740/1 ORBL/SUB-79/45740/1 ORBL/SUB-7470/1-V1 ORBL/SUB-7470/1-V1 ORBL/TH-7022 ORBL/TH-7022 ORBL/TH-7346 ORBL/TH	PB80-197759
ORNL/CON-43	PB80-197759
ORNL/CON-43	PB80-197759
ORNL/CON-43	PB80-197759
ORNL/CON-43 ORNL/CON-46 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-7470/1-V1 ORNL/TH-70/2 ORNL/TH-7319 ORNL/TH-7319 ORNL/TH-7346 ORO-5262-5-SUPPL ORO-5362-T1 ORO-5362-T1 ORO-5912-T3 ORO-7912-T3 ORO-7912-T3 ORO-7912-T3 ORO-7912-T3 ORO-7913-T3-T3-T3-T3-T3-T3-T3-T3-T3-T3-T3-T3-T3	PB80-197759
ORNL/CON-43	PB80-197759
ORNL/CON-43 ORNL/CON-46 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/TH-7022 DP588 H80-32905 # ORNL/TH-7022 DP586 H80-32905 # ORNL/TH-7319 ORNL/TH-7319 ORNL/TH-7346 ORO-5262-5-SUPPL ORO-5362-T1 ORO-5362-T1 DP0631 N80-28880 # ORO-5912-T3 DP067 N80-32922 # ORO-5912-T3 DP067 N80-32922 # ORO-5912-T3 DP069 N80-30543 # OTA-E-86 A-VOL-2-PT-A-APP-1-4 DP069 N80-30543 # OTA-E-86 C-VOL-2-PT-B-APP-7-9 DP069 N80-29520 # OTA-E-86 C-VOL-2-PT-D-APP-15-17 DP0697 N80-29521 # OTA-E-110 DP0697 N80-29522 # OTA-E-110 DP0697 N80-29522 # OTA-E-110 DP0697 N80-29523 # DP0697 N80-29524 # DP0697 N80-29525 # DP0697 N80-29526 # DP0697 N80-30470 # DP0697 N80-280573 # DP80-158751 DP80-158751 DP80-158751 DP80-166150 DP0697 N80-28088 #	PB80-197759
ORNL/CON-43 ORNL/CON-46 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-797/45740/1 ORNL/SUB-7470/1-V1 ORNL/TH-7022 ORNL/TH-7319 ORNL/TH-7319 ORNL/TH-7346  ORO-5262-5-SUPPL ORO-5362-T1 ORO-5912-T3 ORO-7912-T3 ORO-7912-T3 ORO-7912-T3 ORO-7912-T3 ORO-7912-T3 ORO-7913-T3-T3-T3-T3-T3-T3-T3-T3-T3-T3-T3-T3-T3	PB80-197759
ORNL/CON-43 ORNL/CON-43 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/TH-70/2 ORNL/TH-70/2 ORNL/TH-7319 ORNL/TH-7319 ORNL/TH-7346 ORO-5262-5-SUPPL ORO-5362-T1 ORO-5362-T1 ORO-5912-T3 ORO-5913 ORO-28573 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-28573 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-3880 ORO-3919-T3 ORO-3880 ORO-3919-T3 ORO-5912-T3 ORO-5912-	PB80-197759
ORNL/CON-43 ORNL/CON-43 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/TH-70/2 ORNL/TH-70/2 ORNL/TH-7319 ORNL/TH-7319 ORNL/TH-7346 ORO-5262-5-SUPPL ORO-5362-T1 ORO-5362-T1 ORO-5912-T3 ORO-5913 ORO-28573 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-28573 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-5912-T3 ORO-3880 ORO-3919-T3 ORO-3880 ORO-3919-T3 ORO-5912-T3 ORO-5912-	PB80-197759
ORNL/CON-43 ORNL/CON-46 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/TH-7022 DP588 H80-32905 # ORNL/TH-7022 DP586 H80-32905 # ORNL/TH-7319 ORNL/TH-7319 ORNL/TH-7346 ORO-5262-5-SUPPL ORO-5362-T1 DP0577 H80-32879 # ORO-5362-T1 DP0577 H80-28857 # ORO-5912-T3 DP0677 H80-28857 # ORO-5912-T3 DP0677 H80-32922 # ORO-5912-T3 DP0677 H80-32922 # ORO-5912-T3 DP0677 H80-28574 # ORO-5912-T3 DP0677 H80-28574 # ORO-5912-T3 DP0677 H80-29521 # DP0677 H80-29523 # DP0677 H80-29521 # DP0677 H80-29521 # ORO-5912-T3 DP0677 H80-29521 # DP0677 H80-28574 # DP0677 H80-28574 # DP0677 H80-28573 # DP80-158751 DP80-158751 DP80-168867 DP0577 H80-28488 # DP80-168875 DP80-168875 DP80-168875 DP80-168975 # DP0577 H80-28934 #	PB80-197759
ORNL/CON-43 ORNL/CON-46 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-7470/1-V1 ORNL/TH-7022 ORNL/TH-7319 ORNL/TH-7319 ORNL/TH-7346  ORO-5262-5-SUPPL ORO-5362-T1 ORO-5362-T1 ORO-5912-T3 ORO-5913-T3 O	PB80-197759
ORNL/CON-43 ORNL/CON-46 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/TH-7022 DP0588 BR0-32959 \$ ORNL/TH-7022 DP0586 BR0-32950 \$ ORNL/TH-7319 ORNL/TH-7319 ORNL/TH-7346 ORO-5262-5-SUPPL ORO-5362-T1 ORO-5362-T1 ORO-5912-T3 ORO-59	PB80-197759
ORNL/CON-43 ORNL/CON-46 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-79/45740/1 ORNL/SUB-7470/1-V1 ORNL/TH-7022 ORNL/TH-7319 ORNL/TH-7319 ORNL/TH-7346  ORO-5262-5-SUPPL ORO-5362-T1 ORO-5362-T1 ORO-5912-T3 ORO-5913-T3 O	PB80-197759

#### REPORT/ACCESSION NUMBER INDEX

		1	SAE PAPER 800204	p0773	A80-49731
POLY-M/AE-79-64	p0656	N80-32961 #	SAB PAPER 800745		
•,			SAE PAPER 800756	p0664	A80-49704
PR-3	p0692	N80-28560 #	SAB PAPER 800767		
PR-10	p0708	N80-32545 #	SAE PAPER 800769	p0680	A80-49713
PR-15					
PR-19	p0700	N80-30551 #	SAN-0034-239-1-T2	p0666	N80-31927 #
•	•		SAN-0113-040-T6	p0648	N80-31953 #
PRRL-79-CR-47	p0653	¥80-32921 #	SAN-0113-040-T7		
	•	· · ·	SAN-0115-105-1	p0752	N80-32865 #
PUB-LAW-96-316	p0581	N80-30226 # 1	SAN-0419-1		
	•		SAN-1167-1	p0666	N80-31650 #
QPR-1	p0709	N80-32557 #	SAN-1212-T1		N80-30756 #
QPR-1			SAN-1429-52		
QPR-3	p0642	880-30921 #	SAN-1429-56		
QPR-3	p0653	N80-32915 #	SAN-1731-T2	p0577	N80-28856 #
QPR-7	p0695	N80-29472 #	SAN-1889-T1	p0746	N80-30934 #
QPR-15			SAN-2207-T4		
		l l	SAN-11276-2		
QR-1	p0690	N80-28482 #	SAN-13108-35		
QR-1				•	
QR-1			SAND-78-0984	p0750	N80-31958 #
QR-1/2			SAND-78-1962		
QR-2	p0690	N80-28545 #	SAND-78-8176	p0776	N80-30924 #
QR-3			SAND-79-1990	p0741	N80-28756 #
QR-3	p0691	N80-28553 #	SAND-79-2006C		
QR-3	p0749	N80-31882*#	SAND-79-2032	p0631	N80-28876 #
QR-5	p0710	N80-32569 #	SAND-79-2044C		
QR-10	p0691	N80-28552 #	SAND-79-2056	p0775	N80-28878 #
OR-14	p0704	N80-31636 #	SAND-79-2134C		
QR-20	p0692	N80-28562 #	SAND-79-2148C		
•	-	į	SAND-79-2270C		
QTPR-1			SAND-79-2371C		N80-29889 #
QTPR-2	p0642	N80-30912 #	SAND-79-7008	p0652	N80-32890 #
QTPR-2	p0645	ม80-31904 #	SAND-79-7018/2-VOL-2	p0586	N80-32870 #
QTPR-2	p0654	N80-32934 #	SAND-79-7018/3	p0652	N80-32891 #
QTPR-3	p0632	N80-28895 #	SAND-79-7052	p0659	N80-33911 #
QTPR-5	p0704	N80-31640 #	SAND-79-7054	p0584	N80-31950 #
QTPR-8			SAND-79-7056		
QTPR-9	p0696	N80-29513 #	SAND-79-7097	p0778	N80-32898 #
QTPR-9	p0750	N80-31936 #	SAND-79-8198	p0652	N80-32889 #
QTPR-10	p0750	₩80-31936 #	SAND-80-0123	p0709	N80-32560 #
QTPR-11	p0751	N80-32234 #	SAND-80-0309	p0693	N80-28874 #
QTPR-13			SAND-80-0482		
QTPR-14	p0703	N80-31631 #	SAND-80-0550C	p0715	N80-34239 #
			SAND-80-0587C		N80-32935 #
QTSR-1	p0701	N80-30557 #	SAND-80-0749C	p0655	N80-32937 #
	•		SAND-80-0801C	p0633	N80-28912 #
R-2595-DOB	p0749	N80-31885 #	SAND-80-0865-REV	p0651	N80-32887 #
			SAND-80-0926C	p0582	N80-30923 #
REPT-46			SAND-80-1025	p0706	N80-31655 #
REPT-46-APP	p0693	N80-28573 #	SAND-80-1045C		N80-32953 #
REPT-80-9E6-MARED-R3	p0749	N80-31882*#	SAND-80-1569C		
REPT-80-1489	p0641	N80-30898**	SAND-80-7006		N80-28908 #
REPT-624 RL'106	p0705	N80-31653 #	SAND-80-7008		N80-31942 #
EEPT-1987	p0708	¥80-32545 # .	SAND-80-7010	p0648	N80-31949 #
			SAND-80-7011		
RFP-3004-VOL-1			SAND-80-7023		
RFP-3004-VOL-2			SAND-80-8175		
RPP-3014-VOL-1			SAND-80-8203	p0642	N80-30911 #
RFP-3033/3533/79-4	p0742	N80-28926 #	SAND-80-8218	p0646	N80-31918 #
BFP-3034/3533/79-5	p0746	N60-30931 #	scence ocin	- 6	200 20055:
RFP-3035/3533/79-10	pu/42	N8U-28925 #	SC5106.86AR	pu651	N8U-32857##
RFP-3085	P0/52	. BOU-32/22 #	SDO-SENO	-0770	NOA 22007 #
DY 0- 2227 - M2/I - 70 /1	20600	1160-2000C #	SDO-5540	pu//8	BOU-32831 #
R10-2227-T24-79/1	P0694	# QKG27-02#	SPDT /mn_62_26A	20630	x00_20002 #
RLO-2332-3	P0200	200-21000 A	SERI/TP-63-350		
R10-2438-78/1 R10-2438-78/2	P0706	NOU-31900 #	SERI/TP-331-541		
			SERI/TP-333-507		
RLO-2439-79/3			SERI/TP-333-591		
K10-2443-77/1	P0047	MON-31330 .	SERI/TP-334-478		
RRC-79-R-727	20776	NOU-3003" 4	SERI/TP-334-565		
			SERI/TP-351-540		
RRC-80-R-678	2002	MON-25003 4	SERI/TP-351-545		
R35-40	D0755	M80-33862##	SERI/TP-623-656		
R80-914617-1	D0800	NAU-30224	SERI/TP-632-584		
WAA NEARLE I STREET	50000	700 20222-A	SEBI/TP-635-469		
S/W-PROC-111579	n0713	NRO-33500 #	SERI/TP-641-619		
N/ = 2400-111013 **************		200 33333 ¥	SEBI/TP-721-574		
GAR BARR GOOGET	p			20113	
		A80-49718		D0779	
SAE PAPER 800057	p0772		SERI/TP-721-610		N80-32949 #
SAE PAPER 800059	p0772 p0736	A80-49720	SERI/TP-721-610	p0651	N80-32949 # N80-32863 #
SAE PAPER 800059 SAE PAPER 800064	p0772 p0736 p0772	A80-49720 A80-49723*	SERI/TP-721-610 SERI/TP-731-626 SERI/TP-731-649	p0651 p0744	N80-32949 # N80-32863 # N80-29891 #
SAE PAPER 800059 SAE PAPER 800064 SAE PAPER 800099	p0772 p0736 p0772 p0736	A80-49720 A80-49723* A80-49724*	SERI/TP-721-610 SERI/TP-731-626 SERI/TP-731-649 SERI/TP-732-600	p0651 p0744 p0753	N80-32949 # N80-32863 # N80-29891 # N80-32956 #
SAE PAPEE 800059SAE PAPEE 800064SAE PAPEE 800009SAE PAPEE 8000108SAE PAPEE 800108	p0772 p0736 p0772 p0736 p0773	A80-49720 A80-49723* A80-49724* A80-49726	SERI/TP-721-610 SERI/TP-731-626 SERI/TP-731-649 SERI/TP-732-600 SERI/TP-733-617	p0651 p0744 p0753 p0655	N80-32949 # N80-32863 # N80-29891 # N80-32956 # N80-32947 #
SAE PAPEE 800059 SAE PAPEE 800064 SAE PAPEE 800099 SAE PAPEE 800108 SAE PAPEE 800109	p0772 p0736 p0772 p0736 p0773 p0680	A80~49720 A80~49723* A80~49724* A80~49726 A80~49727	SERI/TP-721-610 SERI/TP-731-626 SERI/TP-731-649 SERI/TP-732-600 SERI/TP-733-617 SERI/TR-33-239-VOL-3 SERI/TR-34-093	p0651 p0744 p0753 p0655 p0705 p0646	N80-32949 # N80-32863 # N80-29891 # N80-32956 # N80-32947 # N80-31648 # N80-31916 #
SAE PAPEE 800059 SAE PAPEE 800064 SAE PAPEE 800099 SAE PAPEE 800108 SAE PAPEE 800109 SAE PAPEE 800111	p0772 p0736 p0772 p0736 p0773 p0680 p0573	A80-49720 A80-49723* A80-49724* A80-49726 A80-49727 A80-49727	SERI/TP-721-610 SERI/TP-731-626 SERI/TP-731-649 SERI/TP-732-600 SERI/TP-733-617 SERI/TR-33-239-VOL-3 SERI/TR-34-093 SERI/TR-35-078-VOL-3	p0651 p0744 p0753 p0655 p0705 p0646	N80-32949 # N80-32863 # N80-29891 # N80-32956 # N80-32947 # N80-31648 # N80-31916 # N80-28569 #
SAE PAPEE 800059 SAE PAPEE 800064 SAE PAPEE 800099 SAE PAPEE 800108 SAE PAPEE 800109	p0772 p0736 p0772 p0736 p0773 p0680 p0573 p0773	A80-49720 A80-49723* A80-49724* A80-49726 A80-49727 A80-49728 A80-49729	SERI/TP-721-610 SERI/TP-731-626 SERI/TP-731-649 SERI/TP-732-600 SERI/TP-733-617 SERI/TR-33-239-VOL-3	p0651 p0744 p0753 p0655 p0705 p0646	N80-32949 # N80-32863 # N80-29891 # N80-32956 # N80-32947 # N80-31648 # N80-31916 # N80-28569 #

#### REPORT/ACCESSION NUMBER INDEX

SERI/TR-351-358-VOL-2	p0645	N80-31899 #	
SERI/TE-351-494	p0632	#80-28894 #	
SERI/TR-352-504	p0656	H80-32959 # H80-31911 #	
SERI/TR-631-336	p0646		
SERI/TR-631-387	p0637	#80-29872 #	
SERI/TR-632-439	p0632	NEO-28893 #	
SERI/TR-98298-1	p0751	N80-32462 #	
SNIAS-792-421-101	p0775	N80-28929 #	
SBIAS-792-422-109	p0775	N80-28930 ₽	
SHIAS-792-422-112	p0579	B80-29210 #	
SHIAS-801-422-101	p0782	N80-32297	
SOLAE/0010-79/12	p0633	B80-28947 #	
SOLAB/0010-80/02	p0649	880-31975 #	
SOLAR/0802-79/01	p0632	180-28889 #	
SOLAR/1028-79/50	p0646	M80-31920 #	
SSD-79-0010-1-VOL-1	p0759	H80-30901*#	
SSD-79-0010-1-10E-1	p0760	N80-31890*#	
SSD-79-0010-3	p0651	B80-32860*#	j
SSD-79-0010-5	p0651	N80-32861*#	
. SSD-79-0010-6	p0651	B80-32859*#	
SSD-79-0010-7-VOL-7	p0759	180-30900+#	
SX/115/PL-2	p0644	N80-31876*#	
TAC-STEC-79-002	p0649	N80-31963*#	
TBB-80-13 ,	ġ0590	N80-33018 #	
TH-78-E-91	p0742	N80-28931 <b>♦</b>	
TH-78-B-92	p0744	N80-30198 #	
	-		
TID-28706	p0579	N80-29833	
TID-29379	p0693	N80-28858 <b>#</b>	
TPR-6	p0633	N80-28928 #	
TPR-9		¥80-29899 #	
mpg 70 006	-0500	**************************************	
TPS-78-826	basea	#80-32987 #	•
TQPR-3	p0637	B80-29873 #	
	•		
TR-198A	p0707	N80-31912 #	
TR-209	P0 /0 1	N80-30909 #	
TSD-2	p0589	N80-32988 #	
·	_		
TSR-1	p0751	#80-31960 <b>#</b>	
UCID-18592	p0637	N80-29875 #	
UCRL-TRABS-11585	-0605	N80-29504 #	
UCHL-IHABS-11303	p0695	MOU-29304 #	
UCRL-13982-REV-1	p0775	N80-28884 #	
UCRL-50026-79-4	p0705	N80-31654 #	
UCRL-52000-80-6	p0588	N80-32909 #	
UCRL-52933 UCRL-52942	p0778	N80-32907 # N80-32566 #	
UCRL-83506	p0631	N80-28877 #	
UCRL-83824	p0778	N80-32940 #	
UCRL-84018	p0754	N80-33237 <b>♦</b>	
UCRL-84366	P0709	#80-32565 #	
UCRL-84411			
UCRL-84458		N80-31652 #	
UBLMEPCL-80-1	•		
TC_D1PDVE_1DDT_CV_1280EC	20700	#00-330E7#A	
US-PATENT-APPL-SN-134855			
US-PATENT-APPL-SN-183707	p0583	N80-31472*#	
US-PATENT-APPL-SH-183707	p0650	N80-32850*#	
US-PATENT-APPL-SH-696374	p0634	#80-29835*	
US-PATENT-CLASS-148-1.5	n0630	N80-29835*	
US-PATENT-CLASS-140-115			
US-PATRNT-CLASS-357-52	p0634	N80-29835*	
US-PATENI-CLASS-357-91			
US-PATENT-4,090,213	p0634	B80-29835*	
OTC-FCR-1333-VOL-3			
UHRL/H-80/02	p0649	N80-31967 #	
VPI-E-80-1	n0633	N80-28936 #	

VPI-E-80-1-APP-1	p0633	B80-28937	•
WASH-2330-78/4-VOL-1	p0746	B80-30930	
#80-04604 #80-05011			

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	Energy Conversion Energy Policy Solar Energy Wind Energy	· .		Unclassi	fied - Unlimit	ed
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16. A	Abstract					
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	A Continuing Bibliograph	y (Issue 28)			6. Performing Organia	ation Code
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1. R	eport No. NASA SP-7043(28)	2. Government Access	sion No.		3. Recipient's Catalog	No.

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